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## Extraordinary Ice Jams at Niagara Falls.

[Contributed.]

The ice conditions in the Niagara River, this spring, have been so unusual as to be worthy of record. On Feb. 14, 15 and 16, the American channel at Niagara Falls was completely blocked with ice, causing the rare spectacle of the American Falls going almost completely dry, a condition observed only twice before since the surrounding country has been inhabited by white men—once on March 29, 1848, and again on March 22, 1903. The river ran comparatively free from ice from Feb. 17 to April 9, when the ice again began to run and jammed in the Niagara River, this time in the gorge below the Falls, causing an unprecedented rise all along the river from Niagara Falls to its outlet into Lake Ontario at Youngstown and doing considerable damage to structures located on the banks.

THE DRY NIAGARA.—The winter of 1908-09 was comparatively mild, and the ice in the Great Lakes above Niagara froze in a thinner sheet than usual. Consequently a gale from the southwest on Feb. 12 and 13 quickly broke up the ice sheet in Lake Erie and crowded it down the lake to the head of the Niagara River at Buffalo.

A shoal extends from the head of Goat Island in the Niagara River across the American channel to Grass Island, as will be seen by reference to the accompanying map of Niagara Falls and vicinity (Figs. 1 and 3), and the entire American channel is comparatively shallow. On Saturday, Feb. 13, a high wind, blowing from the northeast, forced back the water in the river so that ice coming down was stranded on the rocks of the shoal. The oncoming flow lodged behind this and, aided by freezing temperature, solidified into an ice dam extending from the Three Sister Islands across the American channel up to the

NIAGARA GORGE SEEN FROM ABOVE THE WHIRLPOOL; APRIL 10.

Carborundum Co.'s plant and forming a field of ice along the south side of Goat Island extending some 200 ft. into the Canadian channel and down to the brink of the falls. The location and extent of this ice formation is shown on Fig. 1.

By Sunday, Feb. 14, the American channel had become entirely dry save for a few insignificant streams of water which found their way through devious crevices in the ice wall and trickled over

All day Thursday, April 8, the ice kept coming down stream and as the wind had changed to the north in the meantime, the current was unable to carry the ice away from the mouth of the river. By night the river was jammed full from its mouth up to the suspension bridge at Lewiston and, with the exception of a few holes, to the foot of the Whirlpool Rapids. By the following day the ice had risen, all along this length, from

The front page cut is a view of [illegible] ing downstream from a point a[illegible] pool, showing the tracks of t[illegible] covered with ice. Fig. 4 is a vie[illegible] stream with the Lewiston Susp[illegible] the middle distance and show[illegible] glacier-like formation extending [illegible] Lake Ontario. Figs. 6 and 7 [illegible] views near Lewiston giving so[illegible]

Gorge look[illegible] the whirl[illegible] Gorge Route [illegible] king down[illegible] n Bridge in [illegible] n unbroken [illegible] n miles to [illegible] close range [illegible] idea of the

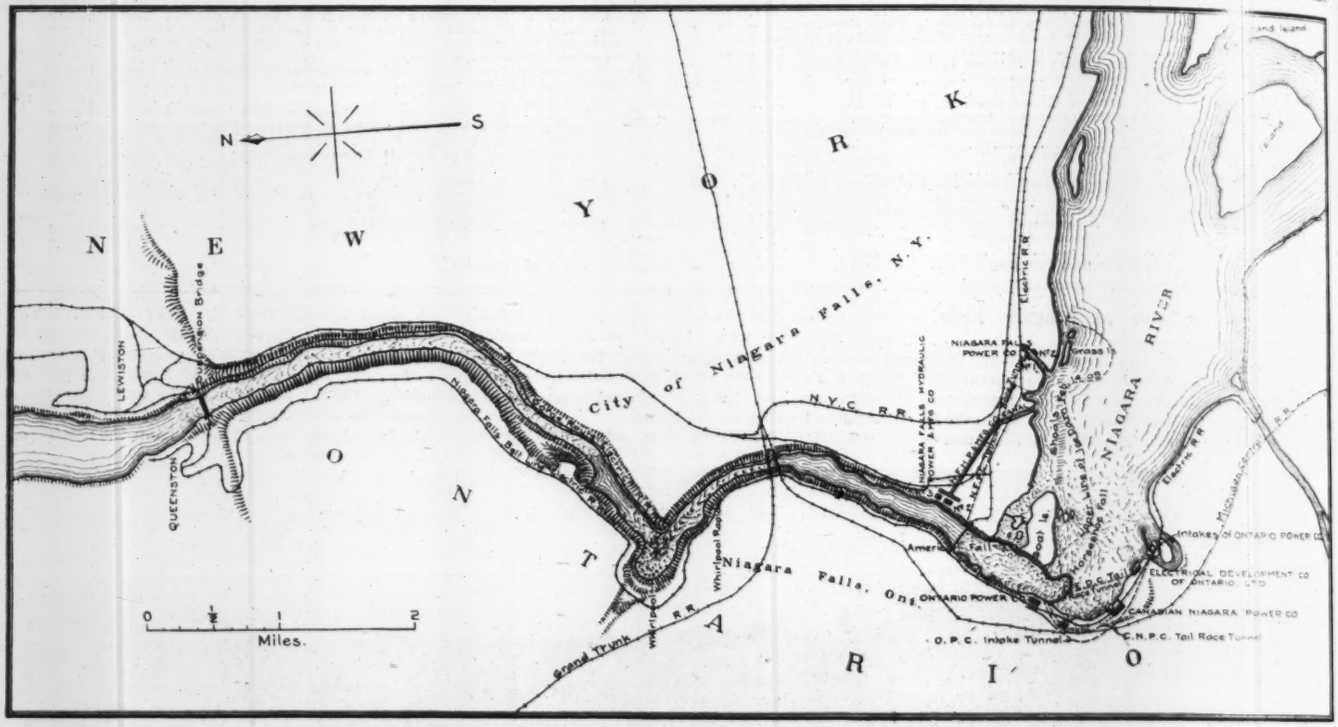


FIG. 1. MAP OF NIAGARA FALLS AND RIVER, SHOWING ICE TROUBLES OF 1909.

the brink of the falls. Adventurous persons walked dry shod in the bed of the river. The photographs* reproduced in Figs. 2, 11 and 12 were taken on Monday, Feb. 15. Fig. 2 is a view looking up the American channel from Goat Island Bridge. Fig. 11 shows the brink of the American Falls as seen from Goat Island, and Fig. 12 the same falls as they appeared from the Canadian side of the river.

The Horseshoe Fall is ordinarily free from the influence of ice, but on this occasion the combined retarding action of the wind and the ice sheet, extending out from the Sister Islands, reduced the flow to about half its normal amount.

The effect of the ice jam on the power developments and industries located on the American side was severe. The intake of the Niagara Falls Hydraulic Power & Manufacturing Co.'s canal and the forebay of the Niagara Falls Power Co. were blocked with ice, necessitating opening and maintaining the passages by blasting and the use of ice breakers. The paper and pulp mills drawing water from the canal were compelled to shut down owing to lack of water. The Niagara Falls Power Co. had assistance from the Canadian Niagara Power Co. and was able to supply the usual demand for power.

The power plants on the Canadian side were kept running without great difficulty. The Canadian Niagara Co. kept its intakes clear of ice by blasting and by employing a force of men to keep the ice moving away from the racks.

The direction of the wind changed on Tuesday, Feb. 16 and, with warmer weather following, the ice jam gradually gave way and passed over the Falls, restoring the river to its usual condition in a few days.†

THE GORGE JAM.—On Wednesday, April 7, a severe wind storm passed over the central and Eastern States, with west winds prevailing. The gale broke up and freed the great ice floe on Lake Erie and the northern lakes and forced the ice in enormous quantities down Niagara River.

*Figs. 11-16 are on an inset sheet.

†[An account of this ice trouble appeared in Engineering News, March 4.—Ed.]

20 to 40 ft. above the normal level of the river, covering the tracks of the Gorge Route Electric Railway for six miles, snapping off the poles and shearing off fills and culverts. The piers of the Niagara Navigation Co.'s dock at Niagara-On-

height of the jam and the wreckage strewn in its path.

While the whole river was rising, a second jam formed farther up, between the head of the Whirlpool Rapids and the Falls, and caused the

FIG. 2. LOOKING UP THE AMERICAN RAPIDS ABOVE NIAGARA FALLS, FROM GOAT ISLAND BRIDGE, FEBRUARY 15, 1909.

The-Lake and at Lewiston were buried under 15 ft. of ice. Boat houses and piers along the river were demolished like egg shells. The transmission line of the Ontario Power Co., which crosses the river at Devil's Hole was broken, the piers on which the towers rested being pushed from their footings.

river to rise, in this stretch, far beyond the highest point ever known in history. The highest level reached in the past has been [illegible] ft. above normal water level. The conditions on the morning of Saturday, April 10, caused this record to be exceeded by 12 ft, creating a new record of 40 ft. above normal level. The Ontario Power

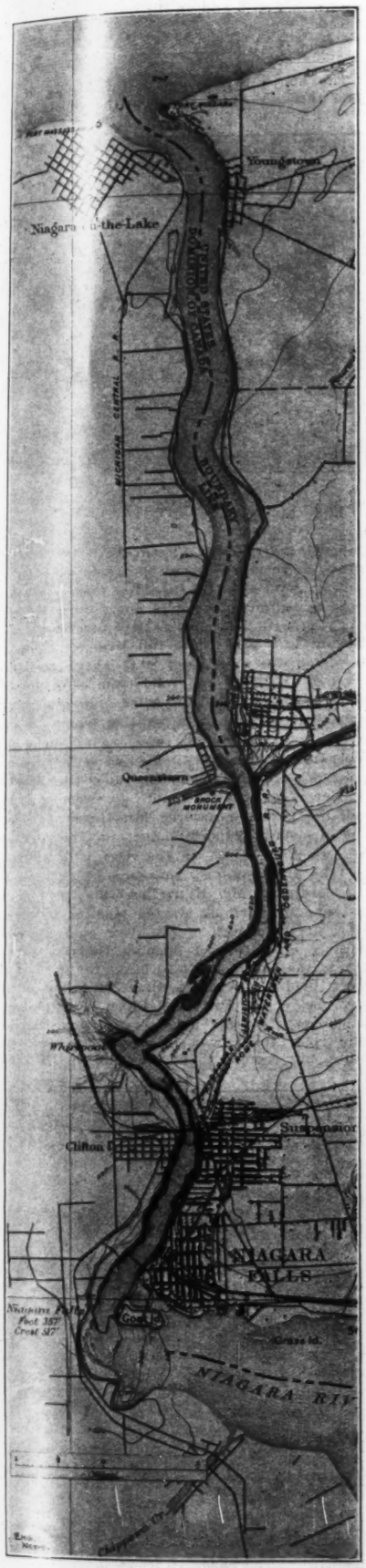


Fig. 3. Map of the Niagara River from above the Falls to Lake Ontario.
(Reproduced from U. S. Geological Survey Chart.)

Co., whose power house is situated near the foot of the Horseshoe Fall, was compelled to suspend operation shortly after 10 o'clock Friday night and the power-house was soon filled with water and ice, which broke through the doors and windows and poured over the floor. The maximum height was reached about 4 a. m. Saturday, after which the ice slowly subsided until it had dropped about 20 ft. Ice was piled up about the abutments, and into the steel work of the steel arch bridge just below the Falls and for a time it was feared the bridge would be destroyed. Fortunately the ice subsided before this could occur, but when the ice gave way it was found that the upper wing wall was badly crushed. The steamer "Maid of the Mist" was forced up from her position at the foot of the incline and was badly damaged.

Fig. 16 is a view looking up toward the Horseshoe Fall, taken April 10, showing the ice piled about the Ontario Co.'s power house. The point of ice just below the Falls is estimated to be 60 ft. above normal water level. Fig. 14, a view of the American Fall taken April 9, shows the character of the ice and its crushing effects. This hummock was about 90 ft. above normal water level. Fig. 15 is a view of the same on the following day, showing the ice as having sheared off at the edges and having subsided about 20 ft. Fig. 13 is looking downstream under the upper steel-arch bridge, with the power-houses of the Niagara Falls Hydraulic Power & Manufacturing Co. in the distance. It shows the ice piled against the abutment of the arch bridge. Figs. 8 and 9 are general views of the upper ice jam. Fig. 5 shows the Ontario Power Co.'s power-house on April 14, after the ice had dropped 20 ft. and had been partially cleared away by the action of the Falls at the left. The maximum height of the ice is indicated by the five partially boarded windows.

Ice still continued to come down the river for several days, but the jam and water level remained practically stationary until the night of Tuesday, April 13, when the quantity of ice running greatly increased and being unable to get away under the jam as fast as it came down, raised the water again, both at Lewiston and at the Falls. At the latter place it rose, by noon of Wednesday, to within 2 ft. of its high-water mark of a few days previous. It was feared that the jam was about to go out with a rush, in which case the damage would have been enormous. But it did not move and did not even rise with the water so that the only noticeable effect was the wearing of a few holes here and there

Fig. 4. View Down Niagara River toward Lake Ontario.

in its surface, due to the action of the water and the ice running beneath.

The weather continued warm so that the ice had become very rotten by this time and showed little tendency to cohere as fresh masses came down from above. Apparently the water and ice was able, under the increased head, to force a

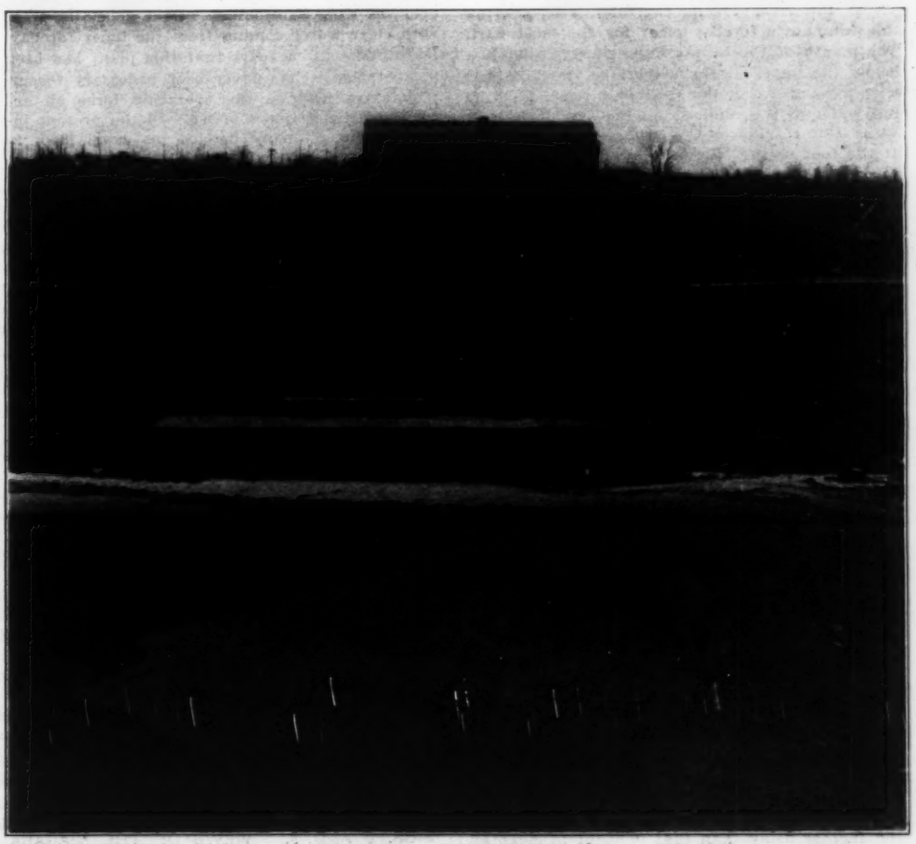

FIG. 5. STATION OF THE ONTARIO POWER CO., ON APRIL 14.

passage under the jam, for the level again fell and by Thursday morning, April 15, had reached a point where it was felt that danger was past.

The effect of the ice jam, in so far as the district adjacent was concerned, was most pronounced in its influence on the plants generating power from the falls and on the industries consuming this power. The power-houses of the Niagara Falls Hydraulic Power & Manufacturing Co. are situated in the Gorge a short distance below the upper steel bridge, on the American side. They were exposed to great danger of being crushed by the ice, but fortunately escaped without injury. Water rose in the basements but did not reach the generating machinery. Some difficulty was also experienced at times in keeping the forebay clear of ice, but it was not necessary to shut down any machinery.

The Niagara Falls Power Co., whose power-houses Nos. 1 and 2 are situated on opposite sides of a short canal on the American side, above the Falls, was most of the time unaffected by the unusual conditions. The action of the wind was such as to drive the down-coming ice floe across the river to the Canadian side, leaving this company's forebay clear for the most part. The mouth of the tailrace tunnel, emptying just below the upper steel arch bridge, was covered with ice and water, but the great velocity of the tail water in the tunnel kept the exit open.

The Ontario Power Co., whose power-house is at the foot of the Horseshoe Fall, suffered most severely. As stated above, the power-house was flooded early Saturday morning. The windows of the power-house are located 7 ft. above the highest previous water mark of 28 ft. and their sills were overtopped by about 5 ft. of water in the first instance. By Tuesday, April 13, it is stated that the water had so far subsided as to allow access to the generator room and to permit the work of cleaning up and drying the generators to begin. However, the power-house was again flooded by the rise on Wednesday following, thus delaying the time when the company could resume the generation of current. On Monday morning, April 12, connection was made between the Ontario Power Co.'s bus bars and the Electrical Development Co.'s plant, one 15,000-HP. generator in the latter plant being placed at the disposal of the Ontario Co. Also a temporary transmission line was quickly erected to connect with the Canadian Niagara Power Co.'s plant and, by Monday night, 10,000 HP. was being received by the Ontario Power Co. from this source. By these means the company was able to supply the demands upon it for lighting and traction service. The industrial concerns obtaining power from this company will be deprived of power for at least two weeks. At Syracuse and Rochester there are steam plants which have been started up and will help overcome the deficiency. For the industries at Lockport there was no course open but to shut down and wait for resumption of operation by the Ontario Co. It is not believed that the damage to this plant will cause any further delay than that incident to cleaning and drying the machinery.

The Canadian Niagara Power Co., whose power-house is a short distance above the Horseshoe Fall, had a good deal of trouble owing to the ice, running in the rapids above, jamming into the forebay. A large force of men was kept busy, night and day, dynamiting ice in this forebay and keeping it moving with rakes and poles. Inside the power-house an ice breaker operated by the electric crane was kept working, breaking up and moving the ice from in front of the racks. By these exertions, the company was able to carry their customary load and help out the Ontario Power Co. to the extent above noted.

The plant of the Electrical Development Co., Ltd., situated just above that of the Canadian Niagara Co., is the only one which entirely escaped the effects of the ice. In the design of the intake works of the plant especial attention was paid to the elimination of ice, and it is worthy of note that under the severest conditions just passed the water was automatically and completely skimmed of ice before entering the inner forebay. Fig. 10 is a photograph taken on Wednesday, April 14, and shows the ice passing over the wing dam outside of the deflecting wall, with clear water coming from the inner forebay. During the three years that this plant has been in operation it has never been necessary to employ extra help on the operating force on account of the presence of ice. In the present instance, the company carried its usual load, in addition to furnishing 15,000 HP. to the Ontario Power Co. as noted.

Acknowledgment is made to Mr. J. Rattray Wilson, Constructing Engineer and Architect, Niagara Falls, N. Y., by whose cour[tesy] the views shown in Fig. 2 and on the inset p[late] are reproduced.

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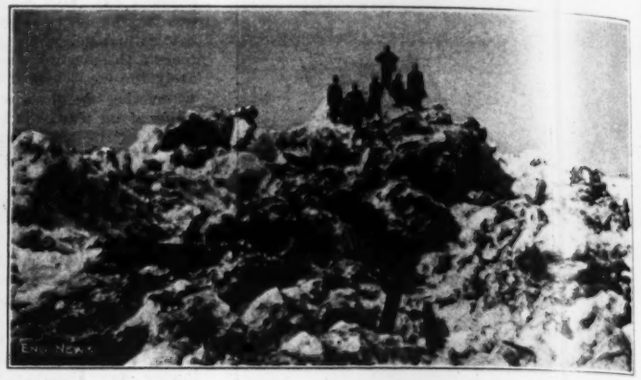
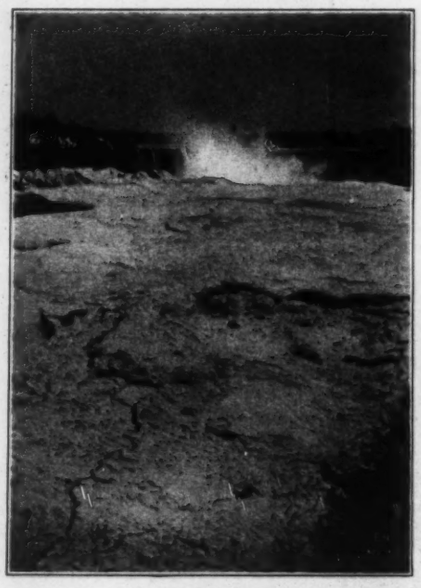
The above article covers the h[istory] of the jam through April 17, when the [crisis] of the danger was reached. From April 18 to 21 the situation remained about the same, with no apparent increase in the height of the ice, but with the glacier moving slowly out toward the lake, carrying with it all shore structures in the way. During this period the top level of the ice at Lewiston was some 75 or 80 ft. above the normal level of the river and solid from bank to bank, though the top of the mass was spongy and apparently slowly disintegrating under the heat of the sun. However, the danger from a possible further rise was then so great that the city officials along the river called upon Gov. Hughes of New York, for state aid. In response to this call the governor ordered Mr. Henry A. Kunze, the Assistant Superintendent of Public Works of New York State, to the river with authority to take any necessary measures of relief.

Accordingly, Mr. Kunze and his corps of assistants on April 22 started blasting in the ice pack at the mouth of the river at Youngstown with a view toward opening there a channel across the bar in order to lower the level of the river behind. At this time the level of the river below the Falls had fallen to normal, and wind conditions did not threaten from the lake. The river itself was ice-bound for about 8½ miles, but seemed to be lowering in the middle



FIGS. 6 AND 7. THE ICE JAM NEAR LEWISTON, N. Y.
(Photographs Copyrighted by M. H. Zahner, Niagara Falls, N. Y.)



FIGS. 8 AND 9. VIEWS OF THE NIAGARA ICE JAM BETWEEN THE WHIRLPOOL AND THE FALLS.

of the ... on the afternoon and evening of April 22 ... am was solid from the Canadian ... fort at the Ontario end of the ... to the ... river ... ed to be tongue-shaped where it was ... wly pushed into the lake. The shore ... retarded the edges so that longitudinal ... lines were plainly visible on both sides of ... ver.

The ... y's blasting had small apparent effect ... ce. The surface was so soft and mushy ... considerable trouble was experienced in placing the explosive, and, for the same reason, the area of shattering was quite limited. Charges of 300 to 500 lbs. of dynamite were fired at a time, and though having small local effect, the heavy waves started from each explosion no doubt tended toward breaking up the pack.

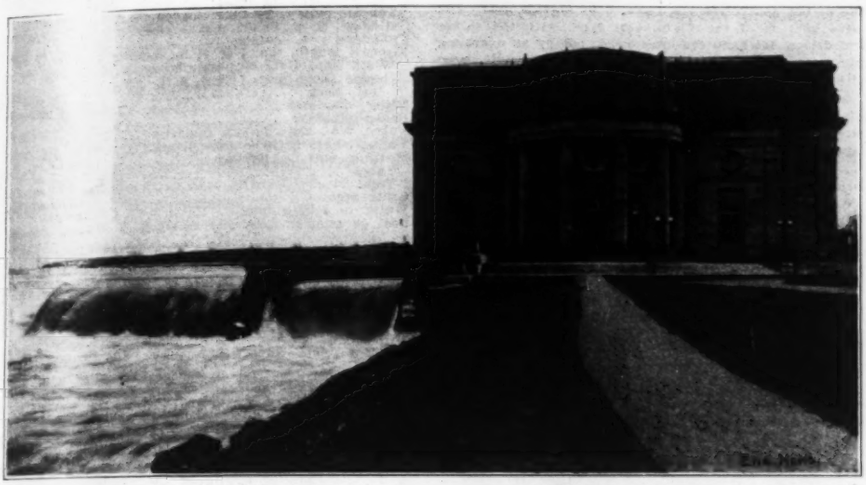


FIG. 10. WING DAM AND FOREBAY OF THE ELECTRICAL DEVELOPMENT CO., APRIL 14.

Meanwhile, the rush of free water over the Falls was having a marked effect on the jam farther down the river. Due partly to this and partly, no doubt, to the continued blasting, there began to appear on the morning of April 23, several large open water spaces on the river between Lewiston and Youngstown. The river all this time was dropping slowly and fresh chunks of ice were coming out of the depths at the mouth of the river, indicating that there was a clear channel of some width at least from the Falls clear through the river. Blasting was kept up through April 24, when it was decided that a sufficient channel had been broken to permit the river to work its own way down to the lake. On this latter date the level at Lewiston was reported as 16 ft. lower than the high water mark recorded. On April 25, there was a clear channel mid-stream from Youngstown up to Suspension Bridge. On either side of the channel the breaking ice stood in places as high as 40 ft., a solid wall above the water. All danger is now passed, but it will be some time before the river is clear or safe for navigation or before the Gorge Road can be reconstructed. The section of the river between the Falls and the Whirlpool Rapids is not as clear as that farther down, and efforts may be made to blast there so that work on the gorge rebuilding may begin soon.

The photograph of the blast shown in Fig. 17 and most of the information from which we have prepared this added matter were furnished us by Mr. J. Rattray Wilson.

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USE OF SOFT COAL in a street railway power station in Brooklyn, N. Y., has been upheld by the Appellate Division of the New York Supreme Court. The street railway company was presented by the Grand Jury a year ago for maintaining a nuisance and criminal proceedings were brought against it. These proceedings are now terminated by the court's decision, which sets forth that the street railway is a public necessity and the equipment necessary to its operation is also a necessity. A public necessity, it is declared, cannot constitute a nuisance.

## A Study of the Discharge of Septic Tank Sludge Into a Tidal Estuary.

The effect of the discharge of septic tank sludge into a tidal estuary is reported on by Dr. Gilbert J. Fowler (Broad Oak, Urmston, near Manchester, England), in an appendix to the latest report of the Royal Commission of Sewage Disposal. The observations in question were made by Dr. Fowler in conjunction with Mr. J. P. Wilkinson, M. Inst. C. E., of Manchester, England. The septic tank in question serves the Admiralty Training Station at Shotley, near Ipswich. This training station is located on a small peninsula between the mouths of the Orwell and Stour rivers. The septic tanks were designed for a population of 2,000. The effluent from the tanks is treated by percolating filters. The first plan was to remove the sludge from the tanks in carts from time to time, "but it was found more convenient to discharge it into the sea at suitable states of the tide." About 9,600 U. S. gals. of mixed sludge and water were let out at each discharge at the time of the observations noted, the operation extending over about half an hour. The sludge valve was opened immediately upon or shortly after high tide, and the track of the sludge observed. Samples of the salt water which had received the sludge were taken for analysis from a boat.

Dr. Fowler's report on these observations covers four large closely printed pages of the report named, and is accompanied by a number of tables and a plan showing the location of the sewage-disposal plant and the course of the discharged sludge. The latter, it appears, was observable for some 800 or 900 ft., spreading out over a narrow fan-shaped area.

The conclusions of Dr. Fowler's report are as follows:

**As a result of the foregoing investigations, therefore, it may be concluded, if sludge consisting of finely comminuted solids, such as accumulate at the exit end of a septic tank, is discharged at the top of the ebb-tide under the conditions obtaining at Shotley, that while a temporary discoloration and pollution of the water takes place in the track of the sludge, yet at no time is the aeration reduced appreciably between tides, and finally the solids are so widely distributed that no visible effect is produced, although the actual transformation of the organic matter requires considerable time.**

**The researches have further shown clearly that, under the conditions of experiment described, nitrification does not proceed so quickly in sea-water as in fresh, and * * * * oxidation of nitrogen only reaches the stage of nitrate formation, in presence of sea-water. It has also been shown that the smell is much more persistent in mixtures of sludge and sea-water than in similar mixtures with fresh water, and therefore special care is necessary, before discharging unoxidized sewage matter into the sea, to be sure that the conditions are such that nuisance cannot arise. In the present case other means of sludge disposal had been provided for, if the sea discharge had been found impracticable. Even as it was the laboratory experiment demonstrated that the amount by volume of the sludge to be added to sea-water must be less than 0.5% if nuisance is not to arise. This was only possible if care was taken to let off at the top of the ebb. If too long time elapsed after the turn of the tide before discharge, the whole of the blackened water was not carried away and remained near the shore till the returning tide. * * * It would appear most probable that the persistent odor of a mixture of sludge and sea-water is due largely, at any rate, to the production of sulphureted hydrogen through the reduction of sulphates. In presence of nitrates it appears reasonable to assume that rapid oxidation of the sulphureted hydrogen would occur. The effect of sea-water on nitrification is, therefore, seen to be an important factor in conditioning the production or otherwise of nuisance, and consequently it becomes necessary more exactly to determine the conditions under which nitrification is retarded or inhibited by sea-water.**

**Further work is also desirable on the mutual interaction of sulphides and nitrates under varying conditions and also on the sources of evil-smelling compounds in mixtures of sewage and sea-water. It is likely that malodorous compounds other than sulphureted hydrogen are also produced by the decomposition of complex nitrogenous substances which may require the presence of nitrates for their rapid oxidation. The well-known effect of nitrates in preventing putrefaction on incubation would point to this conclusion.**

**Researches by the present writer and his assistants are in progress with the object of throwing further light on these points.**

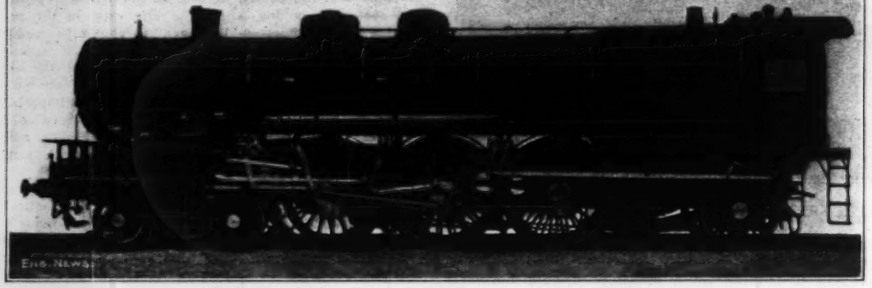
FIG. 17. FIRING A 300-LB. BLAST OFF FORT NIAGARA, YOUNGSTOWN, N. Y.

(Explosion is about 800 ft. from the fort in foreground. Buildings on opposite side of river are those of Fort Massassauga, Canada.)

Dr. Fowler states that the laboratory work which he did in connection with these studies was made in the Public Health Department of the University of Manchester.

## Heavy Passenger Locomotives of the 4:6:2 Class; Western Railway of France.

Locomotives of the Pacific or 4:6:2 class have been adopted extensively in Europe during the past few years for hauling fast and heavy passenger trains, and some interesting notes on the design of large engines of this class are given by Mr. Robert Dubois, Locomotive Engineer of the Western Ry. (of France) in the December number of the "Bulletin" of the International Railway Congress. The railway in question decided about two years ago to introduce locomotives of this class, and built two at its own shops. The specified features of the design were as follows: (1) four-cylinder balanced compound system; (2) driving wheels 76⅝ ins. diameter; (3) wide firebox with 43.06 sq. ft. of grate area; (4) 3,000 sq. ft. of heating surface; (5) maximum load per driving axle, 18 tons; total maximum weight, about 90 tons.



FOUR-CYLINDER COMPOUND HEAVY PASSENGER LOCOMOTIVE OF THE 4:6:2 CLASS (WITH SHORT RIGID WHEELBASE); WESTERN RAILWAY OF FRANCE.

To meet these requirements involved certain difficulties, the principal of these being as follows: (1) to limit the length of the engine; (2) to avoid imposing too heavy a load on the trailing axle; (3) to facilitate the accessibility of the interior mechanism, which is rather hampered by the short distance between the axles and by the large diameter of the wheels; (4) to give the journals of the axles and the bearings of the connecting and coupling rods dimensions suitable for resisting the great loads to which they are subjected owing to the power of the locomotive; (5) to enable the locomotive (together with its tender) to pass sharp curves with safety. The scant limitations of the clearance limits or loading gage of the railway also imposed special restrictions upon the design. The principal dimensions are given in the accompanying table, and the following description is from the paper by Mr. Dubois:

The coupled wheels are close together, the clear space between flanges being only 13/16 in.; and they are as near as possible to the rear wheels of the leading truck. This arrangement of wheels has led to placing the outside cylinders opposite the center of the truck, and to using only one guide bar, which is supported by a cross-beam in front of the leading coupled wheel.

The distribution of the weight is a particularly difficult matter, as the boiler is naturally as a whole placed rather far back. Although the tubes are made longer to compensate for this position, special measures must be taken to avoid an excess load on the trailing axle. Such an excess of load would be all the more injurious because that axle is below the firebox and the wheels have to be of rather small diameter. With this object in view, the front face of the firebox is inclined and tangential to the trailing coupled wheels; the back of the firebox is parallel to the front, except as regards its upper portion, which is made vertical to facilitate the introduction of the stays. Finally, the inside cylinders are placed well forward, as far as the leading wheels of the truck, and act on the leading coupled axle.

This position given to the cylinders results in using high-pressure steam for the inside cylinders. No matter what position might have been selected for the inside cylinders, it would have been difficult to have made them sufficiently large in diameter to use low-pressure steam. It became quite impossible to do so when they were placed as far forward as the leading wheels of the truck. It was necessary to leave enough room for the movements of the truck, and this could not have been obtained with large cylinders unless considerably inclined, thus losing part of the advantages resulting from the direct action on the leading coupled axle.

In order to facilitate the accessibility of the interior mechanism, and in order to give the bearings of the rods and axles sufficiently large dimensions, inside eccentrics are eliminated and the two valve gears on each side of the locomotive are operated by outside gear. The valve gear is of the Walschaert type, with the rocker arm driven not from the cross-head, but by an overhung crank pin of short stroke. This makes it possible, even with a very short rocker arm, to keep the lap very short, and for the same travel of the slide valve to obtain a very late cut-off (in this case 90%). This late cut-off, which is desirable in all cases, is specially advantageous when running a locomotive with piston valves (as fitted on the locomotive of the Western Ry), with throttle closed.

We thus have two advantages, firstly better distribution, secondly greater accessibility, as it is difficult to arrange the rocker arm satisfactorily, if the valve gear is inside. The return crank on the second driving axle operates the two links; the one on the first driving axle operates the two rocker arms of the high and low-pressure cylinders which are on the same side of the locomotive. The two reversing gears are independent and are operated by two separate reversing screws.

The locomotive is necessarily long; it is also necessarily high. The position of the grate above the frame plates, the depth to be given to the firebox, the questions of accessibility inside, all lead to increasing the height of the center line of the boiler, which is 9 ft. 6²⁵/₃₂ ins. above rail-level. It is consequently necessary specially to consider the question of the stability of the locomotive and of its ability to run round curves. The more so, as owing to the geographical position of the railway, its main lines have very sharp curves.

The locomotive is consequently equipped with all the best devices to give it flexibility. The leading truck and trailing pony truck both have short swing links to ensure a quick return. It is also fitted with the best devices for ensuring the proper distribution of the load, and avoiding the unloading of any axle. There are lateral equalizing levers for the different driving wheels and the pony truck. Finally, although a certain amount of lateral play is desirable for the proper maintenance of the track, the bearing springs of the coupled axles are placed above the axle-boxes, owing to the elevation of the center of gravity of the suspended mass. These arrangements have resulted in a locomotive having good stability and taking the curves with ease.

As regards the latter point, the coupling between the locomotive and the tender presents a certain amount of difficulty, because the back of the locomotive is at some distance from its rigid wheelbase. On the one hand, this distance has been reduced by bringing the bumper beam forward below the cab. On the other hand, the lateral displacement of the tender has been facilitated by supporting it in front on a truck with swing links.

In order to facilitate the driving of the locomotive, all the controlling gear is arranged in front of the engineman, who is at the left side on a comfortable folding-seat. The hand-wheel of the reversing gear is arranged like the steering wheel of a motor car, and controls either the high-pressure valve gear, or the low-pressure valve gear, or both together, as may be desired. The throttle, the supplementary valve for admitting steam direct to the receiver, the main brake valve, the starting valve for non-compound running, the handles for operating the sanding apparatus (either by hand or air), the handles controlling the blow-off cocks (operated by compressed air), the speed indicator, etc., are all placed conveniently. The appliances operated by the fireman are placed to the right. All the steam-supply valves are connected to a steam collector, fitted half-way up the back of the firebox. This facilitates the arrangement and the accessibility.

FOUR-CYLINDER COMPOUND PASSENGER LOCOMOTIVE (4:6:2); WESTERN RAILWAY OF FRANCE.

| | |
|---|---|
| Driving wheels | 4⅝ ins. |
| Wheelbase, driving | 4 ins. |
| Wheelbase, engine | 3 ins. |
| Weight, on leading truck | tons. |
| On driving wheels | tons. |
| On trailing truck | tons. |
| Total, in working order | tons. |
| Tender, empty, 24 tons; loaded | tons. |
| Cylinders, h. p., inside (2) | × 25⅝ ins. |
| Cylinders, l. p., outside (2) | 25⅝ ins. |
| Firebox, length, top, 7 ft. ⅝ in., bottom | 3⅝ ins. |
| Width, top, 4 ft. 3⁹/₁₆ ins., bottom | 16⅝ ins. |
| Height above grate, front, 6 ft. 2¹⁵/₁₆ ins., back | 7¼ ins. |
| Boiler, diameter | 6 ins. |
| Boiler pressure | lbs. |
| Tubes, No., 283; outside diameter | ins. |
| Tubes, length between tube plates | 8⅝ ins. |
| Heating surface, firebox | 16 sq. ft. |
| Tubes | 67 sq. ft. |
| Total | 73 sq. ft. |
| Grate area | 06 sq. ft. |
| Water in tender tank | gals. |
| Coal on tender | tons. |

A SUCCESSFUL TEST OF THE REINFORCED concrete reservoir at Fort Meade, S. Dak. (described in our issue of Dec. 28, 1905, p. 680), is reported by Capt. L. C. Scherer, U. S. A., the Constructing Quartermaster at the post. In a letter to the contractors, Messrs. Dunnegan & Sykes, Shenandoah, Iowa, Capt. Scherer writes:

On October 15, 1908, it was entirely filled with water and the valve to the west compartment closed. On April 5, 1909, when the valve was opened, the compartment was still entirely filled, showing that during this interval of 5 months and 20 days not a drop of water leaked from the compartment.

This reservoir, a structure of rectangular plan, with walls and slabs of reinforced concrete with reinforced-concrete columns supporting a slab and beam earth-covered roof, was built under the supervision of Mr. Samuel H. Lea, M. Am. Soc. C. E., now State Engineer of North Dakota.

TESTS ON THE ELECTROLYSIS OF REINFORCED concrete similar to those by Mr. A. A. Knudson, reported in Engineering News, March 21, 1907, p. 328, and by Mr. U. J. Nicholas, in Engineering News, Dec. 24, 1908, p. 710, are reported in the Journal of the Association of Engineering Societies, Feb., 1909, p. 69, by Mr. A. S. Langsdorf. The latter tests were made at Washington University, St. Louis, under the direction of the author, by Mr. M. M. Glauber, and are described as follows.

The tests were divided into two parts, with twelve specimens in each part. All of the specimens consisted of 1½-in. pipe embedded to a depth of 9⅛ ins. in a 1:3:5 concrete, made rather wet and thoroughly tamped. They were composed of Portland cement and crushed limestone. The thickness of concrete all around the pipe was 2 ins. The specimens, after aging for about 30 days, were placed in 6-gal. glazed earthenware jars, raised above the bottom by wooden blocks, and were immersed in fresh water to within about 1 in. of the top of the concrete; fresh water was added as necessary to replace loss through evaporation.

In the first run, eleven of the specimens were then connected in series and a current of 0.05 ampere was passed through them, the twelfth specimen being without current. The run was continued for 70 days continuously. All of the pipes were weighed before embedding in the concrete. At the end of each week one specimen was removed, broken open, and the pipe cleaned and reweighed, showing a progressive loss in weight of about 2½ grams per week.

In the second run, which continued for 33 days, the specimens were connected as before, but the current strength was raised to 0.2 ampere. This run showed a loss of weight of about 7 grams per week. During both runs, readings of the drop of voltage around the specimens were taken at regular intervals. The apparent resistance per specimen, calculated by dividing the volts per sample by the current, varied in the first run from 600 ohms at the start to about 1,200 ohms at the end; in the second test it changed from about 50 ohms at the start to about 500 ohms at the end. Mr. Knudson found an apparent maximum resistance of from 300 to 400 ohms per specimen, but differences in this respect are to be expected because of variations in the density, or porosity, of the samples. It is to be understood that these resistances are apparent only, for they include the effect of a very considerable polarization.

The specimens showed very clearly large radial cracks; in some cases a flaky white deposit formed on the outside surface. Lack of time prevented making an analysis of this deposit but this will be done in a further series of tests. A softening of the concrete was also observed, but not so marked as that reported by previous experimenters, probably on account of the different mixture used. The electrolytic action on the embedded metal was very strong; whereas the specimens not subjected to the current remained clean and bright, the others developed a coating of rust whose thickness increased with the duration of current flow, and in all cases where cracks developed a coating of rust was deposited on the walls of the cracks.

The cracking of the concrete may possibly be explained by the fact that the layer of rust is of rather loose consistency, so that its density is less and its volume greater than of the original material, thus giving rise to a bursting force. The fact that the cracks are mainly radial seems to support this hypothesis.

## Volumes of Segments Cut from Cones: A Problem in Estimating Storage Piles.

By CHAS. A. GILCHRIST.*

Among the various geometrical solids whose volumes the engineer is sometimes called upon to compute, is the slice taken from the side of a cone by a plane parallel to the axis. In a practical form this first came to the writer's attention in the shape of a piece of masonry from the side of a conical lighthouse foundation, and finding no formula given in the various handbooks it revived an interest to derive the formula in a perfectly general and non-empirical form. In an article in the Engineering News of July 27, 1905, p. 89, a formula was presented and fully discussed with special reference to its application to conical storage piles of anthracite coal, the sides of which are sometimes truncated by bins or by retaining walls. The equation there given is susceptible of considerable simplification, even in its general form, and it is also susceptible of simple geometric proof if we assume the expression for the area of an hyperbola to begin with.

The segment whose volume is desired is the shaded part of the cone in Figs. 1 and 2, *R N M Q*. It is fully defined by three quantities or parameters: the cone altitude $h$, the radius of base $r$, and distance of the truncating plane from the axis, $z$. By passing the plane *M N P* through the apex *P* and the line *M N* where the truncating plane intersects the base, we obtain the two solids *P M N Q*, and *P M N R*, whose difference is the desired segment *R M N Q*. These two are conical solids, one with the circular segment $A_c$ as base (Fig. 3) and $h$ for its altitude, the other with the hyperbolic segment $A_h$ for its base (Fig. 1) and $z$ for its altitude. For, each of these solids has a plane base, and sides formed of straight-line elements passing to the apex, and hence is a cone. Therefore their volumes are the product of base area times one-third the altitude.

Letting subscript $c$ denote circle and subscript $h$ denote hyperbola, we have:

$$v = A_c \frac{h}{3} - A_h \frac{z}{3} \qquad (1)$$

It remains now to express $A_c$ and $A_h$ in terms of the given dimensions $h$, $r$, $z$. The area of a circular segment (Fig. 3) is the area of the sector less the area of the triangle:

$$A_c = r \frac{\text{arc } M\,Q\,N}{2} - z\sqrt{r^2 - z^2}$$

The segmental arc is numerically equal to the product of radius and subtended angle *M P N*, if the angle is expressed in circular or radian measure (that is, where unit angle has a unit arc for unit radius). The angle of the half arc is one whose cosine is $\frac{z}{r}$, usually written $cos^{-1}\frac{z}{r}$ and called *inverse cosine* $\frac{z}{r}$ or *arc cosine* $\frac{z}{r}$. Therefore

$$A_c = r^2 \cos^{-1}\frac{z}{r} - z\sqrt{r^2 - z^2}$$

The area of the hyperbolic segment ($A_h$, Fig. 1) is the area of the triangle less the area of the hyperbolic sector:

$$A_h = h\sqrt{r^2 - z^2} - \frac{r}{h}x^2 \log_e\left[\left(\frac{h}{x}\right) + \sqrt{\left(\frac{h}{x}\right)^2 - 1}\right]$$

where $e$ is the base of the natural logarithms 2.71828. The last term cannot be derived without the aid of the calculus, and is therefore to be taken for granted in this demonstration. It is interesting to note that the logarithm indicated is what is known in higher mathematics as the inverse hyperbolic cosine of $\frac{h}{x}$ and may be written $\cosh^{-1}\frac{h}{x}$ and in this form the expressions for $A_c$ and $A_h$ are strikingly alike.

*Manila, P. I.

$$A_c = +r^2 \cos^{-1}\frac{z}{r} - z\sqrt{r^2 - z^2}$$

$$A_h = -\frac{r}{h}x^2 \cosh^{-1}\frac{h}{x} + h\sqrt{r^2 - z^2}$$

Substituting in these $\frac{zh}{r}$ for $x$, we have:

$$A_c = +r^2 \cos^{-1}\frac{z}{r} - z\sqrt{r^2 - z^2}$$

$$A_h = -\frac{h}{r}z^2 \cosh^{-1}\frac{r}{z} + h\sqrt{r^2 - z^2}$$

and substituting these areas in eq. (1) we have:

$$v = \frac{h}{3}\left(r^2 \cos^{-1}\frac{z}{r} + \frac{z^3}{r}\cosh^{-1}\frac{r}{z} - 2z\sqrt{r^2 - z^2}\right)$$

This is the desired formula, but it may be reduced so that only one parameter remains within the parenthesis, by discarding $z$ and using the ratio $\frac{z}{r}$ instead. Calling this ratio $a$ we substitute for $z$ its resulting value $ar$, whence:

$$v = \frac{hr^2}{3}\left(\cos^{-1}a + a^3 \cosh^{-1}\frac{1}{a} - 2a\sqrt{1 - a^2}\right) \qquad (2)$$

This shows that for a given value of the ratio $a$, the volume cut from the cone is the same proportion of the volume of the whole cone whatever the value of $h$ and $r$.

Formula (2) is in its simplest form and the expression in the parenthesis is a function of but one quantity. An inspection of the terms of eq. (2) will show that it is not a good equation for numerical computations, but we can transform it so that all three terms can be obtained from trigonometric tables.

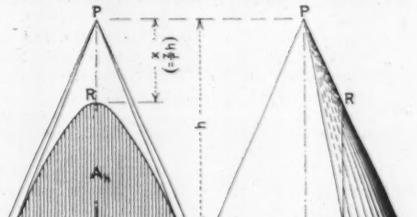


Fig.1.



Fig.2.

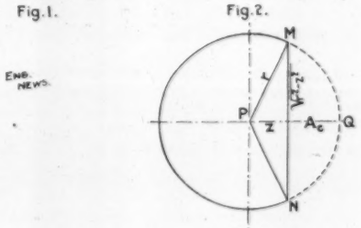


Fig.3.

The first term is in such shape already.

In the third term let $a = \sin b$; then:

$$2a\sqrt{1 - a^2} = 2\sin b \cos b = \sin 2b$$

and since $b = \sin^{-1}a$,

$$2a\sqrt{1 - a^2} = \sin 2\sin^{-1}a$$

which is admirably adapted to table use.

For the second term we have:

$$\cosh^{-1}\frac{1}{a} = \log_e\left[\frac{1}{a} - \sqrt{\left(\frac{1}{a}\right)^2 - 1}\right]$$

as before shown.

$$= \log_e \frac{1 + \sqrt{1 - a^2}}{a}$$

Here also let $a = \sin b$, as before; then:

$$\frac{1 + \sqrt{1 - a^2}}{a} = \frac{1 + \cos b}{\frac{\sin b}{b}} = \cot\frac{b}{2} \quad \text{(by trigonometry)}$$

$$= \cot\frac{1}{2}\sin^{-1}a$$

Therefore

$$\cosh^{-1}\frac{1}{a} = \log_e \cot\frac{1}{2}\sin^{-1}a$$

$$= M \log_{10} \cot\frac{1}{2}\sin^{-1}a$$

where $M$ is that factor necessary to convert common logarithms of base 10 to natural logarithms of base $e = (2.71828)$, or $M = \log_e 10 = 2.3026$.

The first term in eq. (2) is an angle and will quite naturally be taken from the tables in degrees and minutes. Expressing this angle in minutes or seconds only it must be multiplied by some factor "C" to correct it to absolute measure. Where minutes are used $C$ equals .0002909, which is the length of one minute of arc for unit radius.

The whole modified formula now becomes:

$$v = \frac{hr^2}{3}\left[\begin{array}{rr} + & a^3 M \log\cot\tfrac{1}{2}\sin^{-1}a \\ + & C\cos^{-1}a \\ - & \sin 2\sin^{-1}a \end{array}\right] \qquad (3)$$

This is in its very lowest terms for practical use and a trial of it will show that it is far less cumbersome than it appears at first sight. We first look up the angle whose sine is $a$ in a table of natural circular functions; the angle whose cosine is $a$ is found in the same place, for they are complementary angles. The first angle is now doubled, and also halved, and the natural sine of the double angle is the third term. Turning now to a table of logarithmic circular functions the log. cot. of the half angle is taken out and multiplied by the factors shown for the first term.

The formula is not well adapted to the use of logarithms, but if it is desired to use them it will, of course, be necessary to take the logarithm of the logarithm in the first term and to take the logarithm of the actual number of minutes in the second term. Slide rule computations would be serviceable in the first two terms after the indicated extractions from the tables, and again in multiplying the sum by $\frac{hr^3}{3}$.

Persons having continual use for such a formula would be repaid by plotting a curve for one-third the expression in the bracket. An ordinate of this curve corresponding to any given value of $a$ need only be multiplied by $hr^3$ to get the desired volume.

Formula (3) is in the best form for exact numerical computation; formula (2) is in the most rational mathematical form; formula (1) is the most general form, since it applies to the volume cut from a cone by any two planes making any oblique angle whatever, $z$ and $h$ to be taken as the perpendicular distances from the apex to the planes. In the case of oblique planes the areas will be hyperbolic or elliptic and will be difficult to compute, but they may be plotted in the drafting room and integrated by planimeter.

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CANADIAN NORTHWEST COALFIELDS.—The important coalfield lying in the Canadian Rockies, along the common boundary of Alberta and British Columbia, is unofficially reported to have been studied and prospected for the Canadian Geological Survey to determine the extent and character of the deposits. At present the most important part of the field lies in the south about Crow's Nest Pass, near the United States line, although the coalfields are known to extend north to Banff on the Canadian Pacific Ry. The coal measures in the southern part of this field are said to vary in thickness from a few inches to 30 ft., with a total thickness of 200 ft. of coal. Of all this, there is reported 100 ft. in seams at least 3 ft. thick which are considered available for mining. The seams of rock, shale and slate here interspersed with whole coal thickness aggregate some 4,500 ft. The thickness of these rock strata is said to decrease to the northward and eastward, where 175 ft. of coal seams has been found in some 1,200 ft. of rock. The available coal in this whole district is estimated at 45,000,000,000 tons. This is mostly bituminous though some anthracite has been found near Banff and semi-anthracite in the south.

## The International Railway Congress of 1910.

The eighth meeting of the International Railway Congress will be held in Switzerland in 1910, and will be the first since the notable meeting held at Washington, D. C., in 1905. The proceedings (including excursions, etc.) will last for nearly two weeks, from July 3 to 10. Mr. A. Dubois, engineer, who is at the head of the administration of the Belgian State Railways, is President of the Association; its Secretary is Mr. L. Weissenbruch, Chief Engineer of the Belgian State Railways. The local committee in charge of the arrangements for the meeting is composed of Swiss members; its President is Mr. Weissenbach, President of the Swiss Government Railways; and its Secretary is Mr. Murset, who is secretary of the same railway system.

In accordance with the usual custom, the technical subjects on the program will be dealt with by individual papers or reports from members who are specially assigned to this work and who represent various countries or sections. Following the presentation of the papers on any one subject there will be a general discussion of that subject. We give herewith a summary of the matters on the program, with the names of the American writers or "reporters." Where foreign writers are mentioned, these will deal with the subject generally, covering all countries:

1. Rail joints. This will include the reduction in number of joints by increasing the length of rails; maximum length of rails; welding and strengthening joints. Mr. Alexander Ross, Chief Engineer of the Great Northern Ry. (England), is to deal with this subject on the part of all English-speaking countries.

2. Strengthening track and bridges for heavier locomotives and higher speeds of trains. This will cover means of increasing speed on curves without corresponding increase in superelevation; economy of maintenance to be realized by stiffer track; rail sections; substitution of other materials for wood in making ties. Mr. M. L. Byers, Chief Engineer of Maintenance of Way, Missouri Pacific Ry.

3. Means of avoiding the necessity of reducing speed at junctions and drawbridges. Mr. W. G. Besler, Vice-President and General Manager of the Central Ry. of New Jersey.

4. Long railway tunnels; their construction, ventilation and operation: Four foreign writers will deal respectively with the following: (1) submarine tunnels, Mr. Felix Sartiaux, Northern Ry. France; (2) Alpine tunnels, Mr. F. Hennings, Swiss Government Polytechnic School; (3) city tunnels in England, Mr. Francis Fox, Consulting Engineer; (4) mountain tunnels and city tunnels (exclusive of 2 and 3), Mr. Canat, Engineer, Paris, Lyons & Mediterranean Ry.

5. Steel for locomotives and cars; steel freight and passenger cars; special steels of high resistance. Mr. D. F. Crawford, General Superintendent of Motive Power, Pennsylvania Lines, and Mr. R. L. Ettenger, Consulting Mechanical Engineer, Southern Ry.

6. Improvements in locomotive boilers, water-tube boilers; feed-water heaters; superheaters; valve gear for superheated steam. Mr. H. H. Vaughan, Assistant to the President, Canadian Pacific Ry.; Mr. C. B. Dudley, Chemist, Pennsylvania Ry.

7. High-speed locomotives (for regular speeds of over 60 mi. per hr.). Mr. Wm. Garstang, Superintendent of Motive Power, Cleveland, Cincinnati, Chicago & St. Louis Ry.

8. Electric traction on large railways (continuous and alternating current; monophase or polyphase; comparative cost). Mr. Geo. Gibbs, Chief Engineer of Electric Traction, Long Island Ry.

9. Large passenger and freight stations; track arrangements, mechanical handling of baggage and freight. Mr. H. A. Jaggard, Superintendent, Pennsylvania Ry.

10. Switch and signal plants; operation from central towers; locking of switches, use of track diagrams to facilitate the use of tracks in passenger stations. Mr. E. C. Carter, Chief Engineer, Chicago & Northwestern Ry.

11. Passenger tickets; reduction in number of blank tickets. Mr. Von Stierlin, Wurtemberg State Railways.

12. Railway motor cars. Mr. C. P. Clark, Vice-President and General Manager, Buffalo & Susquehanna Ry.

13. Motor wagons for handling freight in cities, and for operating as feeders on country roads. Mr. J. C. Inglis, General Manager, Great Western Ry., England.

14. Railways and waterways; relation of the latter as feeders to and competitors of the former. Mr. W. E. Hoyt, Special Engineer, New York Central Lines.

15. Statistics of railway operation and classification of operating expenses. Mr. E. F. Knibloe, General Agent, Buffalo Creek Ry.

16. Handling perishable freight. Mr. J. M. Culp, Vice-President, Southern Ry.

17. Simplification of operating lines belonging to main railways but having light traffic. Mr. Quarre, Chief Engineer, Southern Ry. of France.

18. Operation of light railways. Mr. Plocq, Chief Engineer of Operation, French Economical Railways Co.

19. Locomotives and rolling stock for narrow-gage light railways. Mr. M. Jesser, Inspector, Southern Ry. of Austria.

20. Freight transfer between lines of different gage. Mr. C. DeBuriet, General Manager, Belgian National Light Ry. Co.

21. Freight car interchange. Mr. W. F. Allen, Secretary, American Railway Association.

## The Missouri River and Its Bridges.

By J. Y. OLESON.*

The Missouri River begins at Three Forks, Montana, at the junction of three rivers, the Jefferson, Madison and Gallatin. It flows into the Mississippi River about 17 miles above St. Louis, making a total length of 2,551 miles. Its principal tributaries are Marias, Milk, Yellowstone, Cannon Ball, Cheyenne, White, Dakota, Big Sioux, Platte, Kansas, Osage and Gasconade Rivers.

The river has a gravel and rocky bed from Three Forks to Carroll, Mont., and the water is very clear. From Carroll to the mouth it flows through alluvial soil, and the water is very muddy. The width of the river is from 600 ft. to a mile, and it has a depth of about 3 to 25 ft. at low water. The drainage area is approximately 580,000 sq. miles.

It has an average slope of 0.88 ft. per mile and a very swift current for so large a stream, flowing from 2 to 3 mi. per hr. at low water and as high as 10 mi. per hr. at high water. This swift current carries with it an enormous amount of sediment, which it deposits in Mississippi River. The total amount per year is estimated at 11,000,000 cu. ft. or one square mile 400 ft. deep. It is the greatest silt carrier in the country, which gives it the name "Muddy."

The greater part of the country through which the Missouri River flows is one of little rainfall, but the river has a large discharge due to the great drainage area and the melting of snows and ice near its source. The maximum discharge is 900,000 sec.-ft., the mean 94,000 sec.-ft. and the minimum 15,000 sec.-ft.

There are two regular floods each year, which usually occur in April and in June. The first is violent and lasts about a week or ten days. The June rise is higher and of longer duration, being influenced by local rains. This rise is followed by a steady fall till freezing closes the upper river; then there is a sudden fall of 3 to 4 ft. and the river reaches its winter level.

The valley in which the river flows varies from 2½ to 17 miles in width. Below St. Joseph the valley averages 2½ miles in width and above that point it widens, being 17 miles in width in the vicinity of Sioux City. The general depth of the rock bed below the surface of the valley varies from 70 to 100 ft. wherever borings have been made.

The difficulties in navigation are the sand-bars, snags, and shallow water; the river being so wide that it has but little depth in many places. However it has been navigated from its mouth to Ft. Benton, Mont., a distance of 2,285 miles, and from Great Falls to Three Forks, Mont.

The Federal Government began its work of improving the river in 1876. This work consisted mostly of snag pulling, bank revetment for protection of the bank, and pile dikes for contracting the channel and thus obtaining a greater depth. The total amount of money spent on improving the entire river is about $11,630,000, or an average of $354,300 per year for the 33 years. The improvement work is now in charge of Captain Edward H. Schulz, Corps of Engineers, U. S. A., Kansas City, Mo.

During the past year there have been three snag boats at work on the river: the "Missouri," which works between St. Louis and Kansas City; the "James B. McPherson," between Kansas City and Sioux City; and the "Mandan," above Sioux City. Snag pulling is very necessary to navigation, as 195 steamboats had been wrecked by snags prior to 1897.

From 1820 to 1880 the river was navigated by a great number of steamboats, and the Northwest country was built up by this transportation at that time. Since 1885, however, the com-

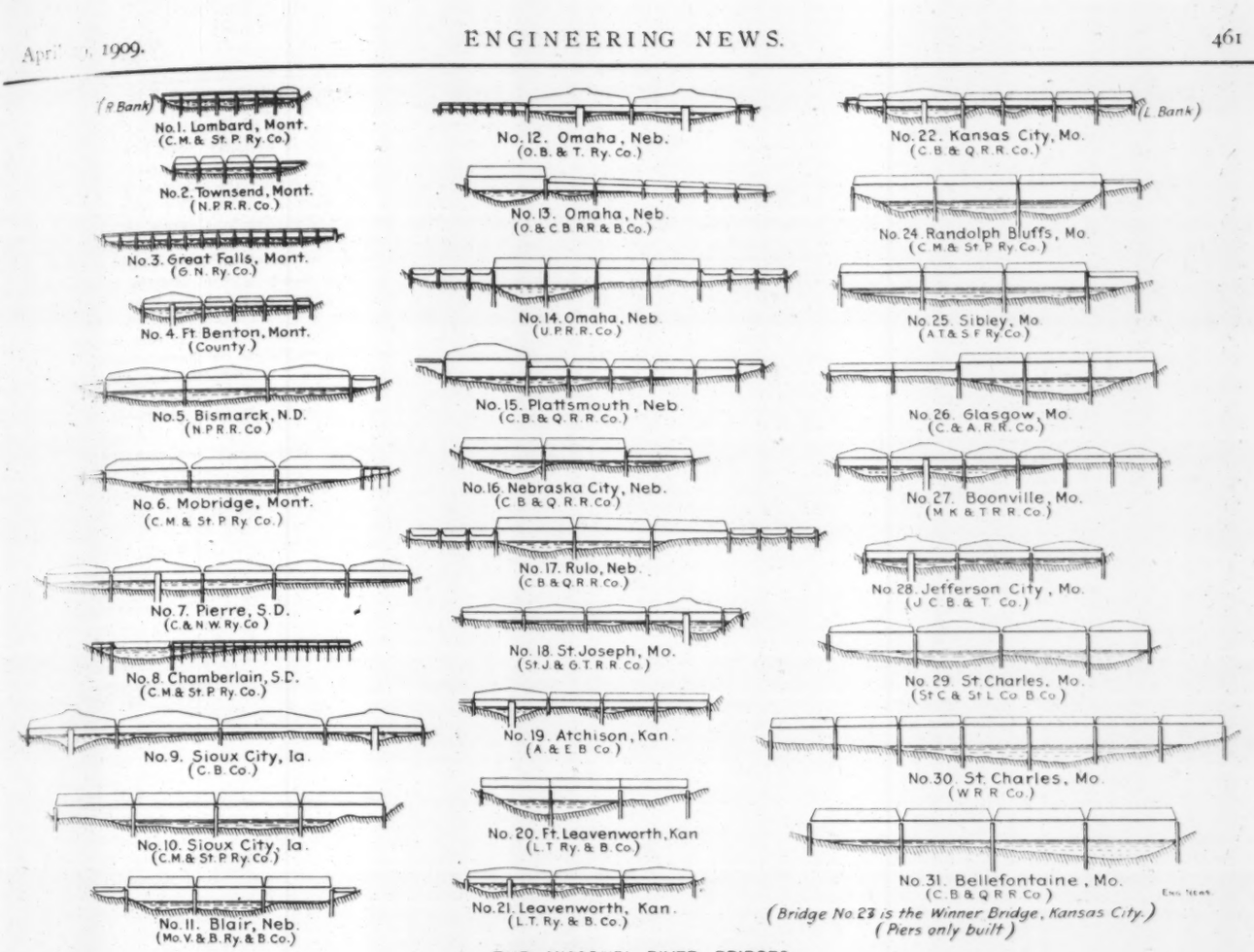
*U. S. Junior Engineer, U. S. Engineer Office, Kansas City, Mo.

DATA OF MISSOURI

(Compiled by J. Y. Oleson, U. S. Junior Engineers from Sioux City to the mouth, and above looking down stream.

| No. | Location. | Miles above mouth. | Present owners. | Completion and reconstruction. |
|---|---|---|---|---|
| 1 | Lombard, Mont. | 2,529.9 | C., M. & St. P. Ry. Co., of Montana | 1907 |
| 2 | Townsend, Mont. | 2,504.1 | Northern Pacific R. R. Co. | 1883 1902 |
| 3 | Great Falls, Mont. | 2,333.4 | Great Northern Ry. Co. | 1900 |
| 4 | Ft. Benton, Mont. | 2,284.8 | Chouteau Co., Mont. | 1888 |
| 5 | Bismarck, N. Dak. | 1,450.1 | Northern Pacific R. R Co. | 1882 1905 |
| 6 | Mobridge, S. Dak. | 1,316.2 | C., M. & St. P. Ry. Co., of South Dakota. | 1907 |
| 7 | Pierre, S. Dak. | 1,174.1 | C. & N. W. Ry Co. | 1907 |
| 8 | Chamberlain, S. Dak. | 1,067.5 | C., M. & St. P. Ry. Co. | 1905 |
| 9 | Sioux City, Iowa. | 807.5 | Combination Bridge Co. | 1896 |
| 10 | Sioux City, Iowa. | 805.7 | Sioux City Bridge Co. | 1888 |
| 11 | Blair, Neb. | 694.6 | Mo. Valley & Blair Ry. & Bridge Co. | 1882 |
| 12 | Omaha, Neb. | 662.2 | Terminal Ry. Co. | 1904 |
| 13 | Omaha, Neb. | 659.7 | Omaha & Council Bluffs R.R. & B'dge Co. | 1888 |
| 14 | Omaha, Neb. | 659.1 | Union Pacific R. R. Co. | 1872 1887 |
| 15 | Plattsmouth, Neb. | 633.6 | C., B. & Q. R. R. Co. | 1880 1903 |
| 16 | Nebraska City, Neb. | 607.7 | C., B. & Q. R. R. Co. | 1888 |
| 17 | Rulo, Neb. | 537.5 | C., B. & Q. R. R. Co. | 1887 |
| 18 | St. Joseph, Mo. | 479.0 | St. Joseph & Grand Island R. R. Co. | 1873 1904 |
| 19 | Atchison, Kan. | 447.8 | Atchison & Eastern Bridge Co. | 1874 |
| 20 | Ft. Leavenworth, Kan. | 424.0 | Leavenworth Terminal Ry. & Bridge Co. | 1872 |
| 21 | Leavenworth, Kan. | 421.8 | Leavenworth Terminal Ry. & Bridge Co. | 1894 |
| 22 | Kansas City, Mo. (Hannibal Bridge). | 390.7 | C., B. & Q. R. R. Co. | 1869 1891 |
| 23 | Kansas City, Mo. (Winner Bridge). | 390.1 | Union Depot Bridge & Terminal Co. | Piers built |
| 24 | Randolph Bluffs, Mo. | 386.7 | C., M. & St. P. Ry. Co. | 1887 |
| 25 | Sibley, Mo. | 350.0 | Atchison, Topeka & Santa Fe Ry. Co. | 1888 |
| 26 | Glasgow, Mo. | 237.5 | Chicago & Alton R. R. Co. | 1879 1900 |
| 27 | Boonville, Mo. | 205.8 | Mo., Kan. & Texas R. R. Co. | 1873 1896 |
| 28 | Jefferson City, Mo. | 151.3 | The Jefferson City Bridge & Transit Co. | 1896 |
| 29 | St. Charles, Mo. | 28.6 | The St. Charles & St. Louis Bridge Co. | 1904 |
| 30 | St. Charles, Mo. | 28.0 | Wabash R. R. Co. | 1873 1884 |
| 31 | Bellefontaine, Mo. | 8.2 | C., B. & Q. R. R. Co. | 1868 |

*Standard high and low water established by U. S.
†L.P.S. = Lowest point of superstructure.
‡Clear openings are given beginning at right bank


(R Bank)
No.1. Lombard, Mont. (C.M.& St.P.Ry.Co.)
No.2. Townsend, Mont. (N.P.R.R.Co.)
No.3. Great Falls, Mont. (G.N.Ry.Co.)
No.4. Ft Benton, Mont. (County.)
No.5. Bismarck, N.D. (N.P.R.R.Co.)
No.6. Mobridge, Mont. (C.M.& St.P.Ry.Co.)
No.7. Pierre, S.D. (C.& N.W.Ry.Co.)
No.8. Chamberlain, S.D. (C.M.& St.P.Ry.Co.)
No.9. Sioux City, Ia. (C.B.Co.)
No.10. Sioux City, Ia. (C.M.& St.P.Ry.Co.)
No.11. Blair, Neb. (Mo.V.& B.Ry.& B.Co.)
No.12. Omaha, Neb. (O.B.& T.Ry.Co.)
No.13. Omaha, Neb. (O.& C.B.R.R.& B.Co.)
No.14. Omaha, Neb. (U.P.R.R.Co.)
No.15. Plattsmouth, Neb. (C.B.& Q.R.R.Co.)
No.16. Nebraska City, Neb. (C.B.& Q.R.R.Co.)
No.17. Rulo, Neb. (C.B.& Q.R.R.Co.)
No.18. St.Joseph, Mo. (St.J.& G.T.R.R.Co.)
No.19. Atchison, Kan. (A.& E.B.Co.)
No.20. Ft.Leavenworth, Kan (L.T.Ry.& B.Co.)
No.21. Leavenworth, Kan. (L.T.Ry.& B.Co.)
(L Bank)
No.22. Kansas City, Mo. (C.B.& Q.R.R.Co.)
No.24. Randolph Bluffs, Mo. (C.M.& St.P.Ry.Co.)
No.25. Sibley, Mo. (A.T.& S.F.Ry.Co.)
No.26. Glasgow, Mo. (C.& A.R.R.Co.)
No.27. Boonville, Mo. (M.K.& T.R.R.Co.)
No.28. Jefferson City, Mo. (J.C.B.& T.Co.)
No.29. St.Charles, Mo. (St.C.& St.L.Co.B.Co.)
No.30. St.Charles, Mo. (W.R.R.Co.)
No.31. Bellefontaine, Mo. (C.B.& Q.R.R.Co.)
Eng. News.
(Bridge No.23 is the Winner Bridge, Kansas City.)
(Piers only built)

THE MISSOURI RIVER BRIDGES.

merce has continually decreased. In 1907 the cities situated on the river awoke to the fact that river navigation could be very beneficial to them, consequently Kansas City bought two boats to run between Kansas City and St. Louis, and they did a very good business during that year and last year. The present agitation for improving our inland waterways will no doubt in the future cause Congress to appropriate large sums of money for improving rivers. The people of the West expect to receive their share to improve the Missouri River for a depth of 6 to 10 ft. from Sioux City to the mouth.

Missouri River bridges are of four classes, high bridges, low bridges, drawbridges and pontoon bridges. The requirements as to height and span, which have been fixed by the War Department, are as follows: Bridges from Sioux City to Platte River must be at least 50 ft. above standard high water, and no spans may be less than 300 ft. From the mouth of the Platte to the mouth of the Kansas City, the height must be 50 ft., the length of channel span 400 ft., and all other spans 300 ft. From the mouth of the Kansas to the mouth of the Missouri River, the height must be 55 ft. and all spans 400 ft. The least span of drawbridge now on the river from Sioux City to the mouth is 156 ft.

There are at present 31 bridges over the river, of which the Hannibal Bridge at Kansas City, Mo., is the oldest, being built in 1869 and reconstructed in 1891. A set of diagrams showing all the existing bridges is appended hereto, and their dimensions, owners, date when built, etc., are listed in a table separately.

RIVER BRIDGES.

Engineer, Kansas City, Mo., 1909.

| Kind of bridge. | Its use. | Spans No. | Spans Clear openings.‡ | Elevations above sea level (in ft.) *S. H. W. | *S. L. W. | †L. P. S. | Clear heights above S.H.W. |
|---|---|---|---|---|---|---|---|
| Low | R. R. | 7 | 75′ each | 3,950.0 | ..... | 3,971.1 | 21.1′ |
| | | | | 3,724.5 | 3,716.8 | 3,732.3 | 7.8′ |
| Low | R. R. | 4 | 109′ 106′ 106′ 109′ | H. W. 1894 | L. W. 1901 | | |
| Low | R. R. | 14 | 2-40′ and 12-80′ | 3,306.4 | ..... | 3,305.5 | —0.9′ |
| | | | | 2,627.6 | 2,616.4 | 2,645.6 | 18.0′ |
| Draw | Wagon | 5 | Total length 824′ | H. W. 1892 | L. W. 1901 | | |
| | | | | 1,645.0 | 1,617.4 | 1,685.0 | 40.0′ |
| High | R. R. | 5 | 108′ 387′ 389′ 387′ 126′ | H. W. 1887 | L. W. 1901 | | |
| High | R. R. | 3 | 409′ 410′ 409′ | 1,614.9 | ..... | 1,664.9 | 50.0′ |
| | | | | 1,439.6 | 1,418.8 | 1,447.5 | 7.9′ |
| Draw | R. R. | 6 | 340′ 210′ 210′ 342′ 342′ 340′ | H. W. 1887 | | | |
| Pontoon | R. R. | | 1 swing span, 300′ & trestles | ..... | ..... | ..... | .... |
| Draw | R.-R.-Wagon | 6 | 216′ 215′ 490′ 490′ 215′ 215′ | 1,093.2 | 1,082.8 | 1,111.5 | 18.3′ |
| High | R. R. | 4 | 390′ 389′ 391′ 388′ | 1,092.0 | 1,081.6 | 1,142.2 | 50.2′ |
| High | R. R. | 3 | 318′ 321′ 319′ | 1,000.2 | 990.5 | 1,053.8 | 53.6′ |
| Draw | R. R.-Wagon | 2 | Two draw spans 520′ each | 977.7 | 968.3 | 989.9 | 12.2′ |
| High | E. R.R.-Wagon | 7 | Spans over river 386′ 237′ | 975.9 | 966.5 | 1,028.6 | 52.7′ |
| | | | | | | 983.8 | |
| High | R. R. | 5 | 238′ 237′ 237′ 236′ 120′ | 975.5 | 966.1 | 1,028.1 | 52.6′ |
| High | R. R. | 6 | 392′ 191′ 192′ 194′ 195′ 193′ | 955.5 | 945.4 | 1,005.7 | 50.2′ |
| | | | | | | 969.2 | |
| High | R. R. | 3 | 392′ 389′ 318′ | 920.2 | 911.5 | 973.7 | 53.5′ |
| High | R. R. | 3 | 365′ 364′ 365′ | 857.2 | 844.0 | 905.7 | 48.5′ |
| Draw | R. R.-Wagon | 5 | 287′ 286′ 288′ 156′ 155′ | 809.4 | 797.4 | 821.5 | 12.1′ |
| Draw | R. R.-Wagon | 5 | 161′ 159′ 245′ 247′ 245′ | 782.9 | 770.5 | 795.6 | 12.7′ |
| High | R. R. | 3 | 328′ 332′ 306′ | 761.6 | 749.0 | 815.5 | 53.9′ |
| Draw | R. R. | 4 | 202′ 201′ 324′ 324′ | 759.6 | 747.0 | 767.9 | 8.3′ |
| Draw | R. R.-Wagon | 7 | 119′ 162′ 156′ 187′ 234′ 189′ 144′ | 737.0 | 722.5 | 766.1 | 29.1′ |
| Low lift span | R. R.-Wagon | 3 | 413′ 401′ 401′ | 736.5 | 722.0 | 801.5 up<br>754.0 down | 65.0′ up<br>17.5′ down |
| High | R. R. | 3 | 389′ 389′ 389′ | 733.7 | 719.4 | 788.7 | 55.0′ |
| High | R. R. | 4 | 383′ 383′ 382′ 237′ | 703.1 | 691.7 | 774.5 | 71.4′ |
| High | R. R. | 5 | 314′ 302′ 303′ 314′ 315′ | 609.6 | 595.0 | 661.7 | 52.1′ |
| Draw | R. R. | 7 | 244′ 214′ 158′ 159′ 245′ 217′ 214′ | 584.0 | 571.6 | 606.7 | 22.7′ |
| Draw | Wagon | 4 | 205′ 205′ 343′ 342′ | 541.6 | 527.0 | 575.6 | 34.0′ |
| High | E. R.R.-Wagon | 4 | 416′ 416′ 416′ 300′ | 437.1 | 421.0 | 493.7 | 56.7′ |
| High | R. R. | 7 | 300′ 294′ 293′ 310′ 305′ 306′ 294′ | 437.0 | 420.9 | 502.7 | 65.7′ |
| High | R. R. | 4 | 431′ 430′ 429′ 429′ | ..... | ..... | 476.1 | .... |

Sioux City the elevations are high and low water given by R. R. companies and U. S. Weather Bureau.

THE DREDGEMASTER.—Laurent Roquebert, general foreman of dredging at La Boca, has been a dredgeman at the Pacific entrance to the Canal for twenty years or more, in fact, since the time of the old French company. While at his work on the evening of March 29 he was crushed between two clapets, and now lies critically ill at Ancon Hospital. Two days after the accident the Resident Engineer at La Boca went to see him and was greeted with the question:

"How many yards?" He referred to the amount of dredging that had been done in March, and when told that all records had been broken, he asked:

"And the 'Gopher'; what did she do?"

The "Gopher," like the dredgemaster, is a heritage from the French. It is a a sea-going Scotch ladder dredge that has been at work at La Boca almost constantly for 25 years. Roquebert was at one time the master on this dredge, and his confidence that it was the best worker in Canal excavation was unshaken until October, 1908, when dredge No. 1 of the Colon fleet took the record.

In answer to the question, "And the 'Gopher'; what did she do" he was told, "She holds the record by over 3,000 yards."

The dredgemaster closed his eyes, sighed in satisfaction and said: "I am so happy!"

The "Gopher" excavated 172,477 cu. yds., place measurement, during March, exceeding the record made by dredge No. 1 of the Atlantic fleet in October, 1908, by 3,681 cu. yds.—Canal Record, April 7.

## Heating a Trolley-Car Barn.

By J. IRVING BREWER.*

In this article the writer has attempted to show the application of data and principles, recognized in good heating practice, to the design of the heating system for a trolley-car barn suitable for inspecting cars and making light repairs on them. The barn is located on the ground underneath the structure of an elevated railroad yard and has the following approximate inside dimensions: length, 105.4 ft.; width, 38.5 ft.; average height, 14.9 ft. The walls are of concrete 12 ins. thick and the roof is of boarding some 2 ins. thick covered with sheet iron and is suspended from the steel structure overhead. The building has 22 windows which are roughly 4 ft. wide by 8 ft. high. These windows are arranged 18 on each of two sides of the barn, and four on one end; the other end of the barn, the south end, has hinged doors comprising a large portion of the end of the barn, through which the cars pass. Inside the barn there is an inspection pit which extends under two car tracks. This pit has the following approximate dimensions: length, 84 ft.; width, 16 ft.; depth, 3.8 ft. The rails of the track are laid on wooden timbers which are supported by concrete pillars in the pit. About two cars can be placed conveniently on each of the two tracks, and the arrangement of the pit is such that workmen can pass from under the cars of one track directly under those of the other track.

Steam heat was desirable, as a boiler plant, for other heating systems, was not far distant. The radiating surface, for such a building as this, consists of coils of wrought-iron pipe in preference to iron castings. The coils can readily be supported on hook plates, along the walls behind work benches, occupying less space than the cast-iron radiators and being less subject to breakage.

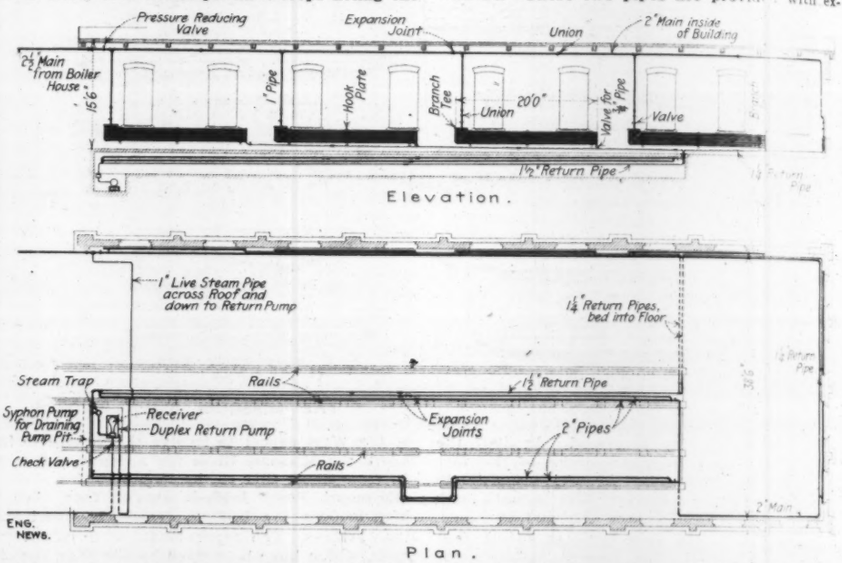
It is desirable not to have such a building too warm. A temperature of 65° to 68° F. seems about right. If the radiating surface is excessive the temperature is too high for men doing manual labor. If the radiating surface on the other hand is insufficient, on cold days, the men are apt to warm themselves in the offices or in other nearby structures which may be warmer than the barn.

A ratio of about 1 sq. ft. of radiating surface to 150 cu. ft. of contents of the building will give satisfactory results for such a barn as here considered, and this ratio may be used as a guide in laying out and arranging the radiating surface. The accompanying drawing is given to show the final arrangement of coils and piping as determined upon for this plant. One and one-fourth-in. wrought-iron pipe was chosen as a convenient size with which to construct the radiating coils. The outside diameter of the pipe being approximately 1⅝ ins., the pipe is easily handled and the coils are not bulky.

On the west wall of the building are placed four coils, each coil consisting of seven 1¼-in. pipes about 20 ft. long; on the north wall are two coils, each consisting of six 1¼-in. pipes about 16 ft. long. The pipes of each coil are spaced about 3 ins. c. to c. and are screwed into a branch T at each end of the coil. The branch T at one end of the coil is vertical, while at the other end of the coil the pipes are turned upward at right angles so that the branch T at this end is horizontal. This arrangement of the coil accommodates unequal expansion of the pipes when the coil is heating or cooling.

It will be seen on the accompanying figure that the steam main for supplying the coils is made 2 ins. in diameter inside the building and is run near the roof along the west and north walls to the northeast corner of the barn, then southward a short distance when it is carried down to the floor to supply heat in the pit. The total length of the steam main inside the building is some 180 ft. It is intended to act as radiating surface and is therefore left bare. The main is fixed rigidly at two points along the wall and expansion in the pipe is provided for by using a sliding expansion joint which consists of a gland and stuffing box. A number of unions are placed in the main to provide for ease in erecting the pipe and in taking it apart for repairs or alterations. From this 2-in. main a 1-in. wrought-iron pipe is carried down to supply each of the coils. Each of these 1-in. branches has a union to facilitate easy coupling, or uncoupling, in case of alterations and a valve near the pipe coil. The branch has also a sort of reverse bend consisting of two elbows and a nipple to accommodate the longitudinal motion in the 2-in. main overhead.

The pipe coils along the wall are supported by hook-plates and are given a slope so as to drain the condensed water towards the discharge end. For melting snow and ice from under cars, the track pit is equipped with heaters consisting of four 2-in. pipes, two of which pipes are supported by hook-plates on each of two walls of the pit. These 2-in. pipes are given a slope so as to drain the condensed water to the south end of the pit. To provide for expansion the two pipes on the westerly side of the pit have sliding expansion joints, while the two pipes on the easterly side of the pit have loops fitting the shape of the pit wall, as shown in the accompanying figure.




PLAN AND SECTIONAL ELEVATION OF A TROLLEY CAR BARN, SHOWING ARRANGEMENT OF HEATING SYSTEM.

For disposing of the condensed water of the plant there is placed on the west wall of the building directly under the coils a 1¼-in. pipe which drains northward to a point opposite the end of the track pit where it is bedded into a small trench in the concrete floor and led across to the track pit. This small trench is covered with a steel plate ¾ × 8 ins., which can readily be removed to expose the return pipe for any repairs. A 1¼-in. return pipe runs along the north and west walls of the building under the radiators and is then led across through the same trench to the track pit. Each of the pipe coils is connected by means of a short ¾-in. outlet pipe with valve, to the return pipe, into which the condensed water drains out of the coil, and since the connection is of a rigid character in this case, some provision for expansion in the return pipe must be made in each space between points where the coils connect to the return pipe. In this particular plant sliding expansion joints are used as being the most feasible. With two valves for each coil, any coil may be cut out of service entirely. The heaters in the track pit are also similarly provided with valves in the inlet and outlet pipes. Where the two 1¼-in return pipes enter the track pit they merge into a single 1½-in. pipe which is sloped to drain the water to the south end of the pit, where all the condensed water from the pipe coils and pit heaters is led into a steam trap, from which it is emptied into a receiver and finally returned through a 2-in. pi… tank in the boiler room by a … pump having a 4½-in. steam cy… 2¾-in. water cylinder, with a 4-in … discharge pipe from the return … check valve near the pump to prev… of discharged water. The trap, … ceiver are placed in a sump. This … was necessary to get the receiver … ciently low level for the returns … it. The sump is kept dry by a … cellar pump operated by water … pressure.

The steam main leading from the … car barn is 2½ ins. in diameter and … long. The 2-in. return main carry… densed water from the car barn … boiler room is of about the same le… two mains are suspended in the ope… overhead structure of the elevated … and are therefore covered to prev… heat. This covering consists of 1/16-… paper, 1-in. Russian hair felt, tw… three-ply tar paper and one thickn… canvas. These two pipes are provid… pansion bends or loops every 100 ft. to accommodate the contraction or expansion in the pipes. None of the piping inside the building is covered.

The 2½-in. steam supply main from the boiler house is reduced to 2 ins. immediately inside the barn and at this point a 2-in. reducing valve is placed to cut down the pressure on the heating coils to about 5 lbs., with 60 or 80 lbs. on the boiler. The steam for operating the return pump is taken from the high pressure main near the reducing valve, through a 1-in. pipe.

The dimensions of building and pipes are shown tabulated below:

| | |
|---|---|
| Cubic contents of the building proper, 105.4 × 38.5 × 14.9 ft. | 60,500 cu. ft. |
| Cubic contents of track pit, 84.0 × 16.0 × 3.8 ft. | 5,100 cu. ft. |
| Total volume | 65,600 cu. ft. |
| Radiating surface: | |
| 4 coils each of 7 pipes 1¼-in. diam., 20 ft. long at 61 sq. ft. per coil | 244 sq. ft. |
| 2 coils each of 6 pipes 1¼-in. dia., 16 ft. long at 42 sq. ft. per coil | 84 sq. ft. |
| 2-in. steam main 180 ft. long at 0.62 sq. ft. per lin. ft. | 112 sq. ft. |
| Total surface of coils and main | 440 sq. ft. |

This gives a ratio of 1 sq. ft. of radiating surface to 149 cu. ft. of contents, which satisfies the conditions laid out in the start. In getting the radiating surface for the desired ratio it is usually necessary to try several pipe sizes and arrangements of coils before a satisfactory result is reached.

It is seen that this does not include the pipe coils in the inspection pits, and it will be re-

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membe[illegible] these were for melting snow and ice on the running gear of the cars.

The [illegible] of the pipe heaters for the track pit is as follows:

| | |
|---|---|
| 4 pipe coils, 2-in. diam., 80 ft. long, 320 lin. ft., at 0.6[illegible] per lin. ft. | 198 sq. ft. |

If the 198 sq. ft. be added to the 440 of that of the [illegible] coils, there results a total radiating surface of 638 sq. ft., making the maximum possible ratio of volume to radiating surface, 103 to 1.

To find the boiler horsepower required to supply the steam to this radiating plant it will be necessary to know the total radiating surface, including the supply main.

| | |
|---|---|
| Total radiating surface inside of building | 638 sq. ft. |
| Main between boilers and car barn, 320 ft. of 2½-in. pipe, at 0.75 sq. ft., per ft. | 240 sq. ft. |
| Total radiating surface to which steam is supplied | 878 sq. ft. |

On the assumption that 1 boiler HP. will supply 90 sq. ft. of radiating surface, the 878 sq. ft. total will demand 9.8 boiler HP.

In the writer's experience, a plant the design of which has been briefly outlined has given satisfaction, the cost of labor and material for the plant installed ready to operate being about $2.15 per sq. ft. of radiating surface, considering only that the surface which is entirely within the building amounting to 638 sq. ft., and excluding the surface of the steam main between the boilers and the building. If the surface of the steam main between the boilers and the building be included as well as the surface inside the building, the cost is about $1.55 per sq. ft. of surface. These cost figures include contractor's profit, and it should be noted that they do not include a plant to generate steam.

STATISTICS OF MINE EXPLOSIONS in Europe are reported by M. J. Taffanel in the Bulletin de la Société de l'Industrie Minerale, for February, 1909. During the 14 years preceding the Courrières mine disaster in 1906, there was not an explosion in France in which there were more than 9 men killed; in the Courrières explosion nearly 1,200 men were killed. The total number of victims in France in fire-damp explosions was 57; the proportional number of such deaths to the total number of mine-workers was 20.3 to 10,000 in 1889, but was reduced in the years 1892-1905 to 0.26 to 10,000 annually. In Belgium during these same 14 years, not including the Anderlues explosion (160 deaths) in 1892, there were 175 fire-damp victims, an annual ratio of deaths of 1.06 to 10,000. In Prussia, there were 13 fire-damp explosions in the 14 years, with 722 deaths, or 1.49 to each 10,000 workmen in each year. In England the same period shows a total of 1,248 fire-damp victims, or 1.20 killed each year to every 10,000 workmen.

A TESTING LABORATORY for the investigation of accidents in mines has been established at Lievin, Department Bas-de-Calais, France. After the terrible mine explosion at Courrières, March 10, 1906, in which about 1,200 miners were killed, the Central Committee of the Coal Mines of France, representing almost all of the coal-mining companies of France, at its own expense, took the initiative of organizing this testing station where may be studied all questions regarding the safety of mines and especially those questions relative to dust explosions. The program outlined for the laboratory is as follows:

First. To study the inflammability of coal dust, the conditions surrounding the formation of such explosions, and means of relieving the dust danger.

Second. To study and control the stability of explosives in mines in the presence of fire-damp or dust, and also the control of mining machinery.

Third. To study and control mine lamps and electrical apparatus used in mines.

Fourth. To study safety and rescue appliances.

Fifth. To found a laboratory of practical and scientific study of all questions of mine safety.

Sixth. To make foreign investigations, particularly to follow notable accidents, and to make from them observations which will increase the security to mines and miners.

For this program $70,000 has been appropriated for a first cost with an annual appropriation of $15,000 for the work. It is in charge of M. J. Taffanel, under the appointment of the French Minister of Mines. The station has been built and some of the investigations have been started, but as yet no publication of results has been given out. A description of the laboratory is published in Le Génie Civil, April 10, 1909.

## The Disadvantages of Concrete Foundations for Railway Crossings.

By R. P. BLACK.*

At the time it was necessary to relay the main line of the Kanawha & Michigan Ry. with 90-lb. rails, concrete foundations were designed and put in under the new crossing frogs where railroad crossings at grade were maintained. The old 70-lb. rail crossings had given considerable trouble on account of bad surface and bolts becoming loose, due to sloppy or wet crossings. The bad condition of the crossings was caused in a great many cases to improper drainage, in others to an insufficient amount of ballast under the ties. The character of the soil in West Virginia is such that it becomes very mushy and soft when not drained, therefore, where ballast was gravel or an insufficient amount of stone, wet crossings were experienced. To overcome this trouble concrete foundations with timberings as shown in the accompanying cut were put in.

Under each rail of the K. & M. Ry. main track were put in three 8 × 10-in. pine timbers of sufficient length to support the joints at the heel of the frogs. Under the rails of the transverse track were put three 8 × 10-in. timbers short lengths mortised into the long timbers. All timbers were well bolted together with ¾-in. bolts. At the ends of the crossings the concrete is 9 ft. wide under the K. & M. Ry. track and 8 ft. 6 ins. wide under the other track. The concrete was put into the top of timbers, with a minimum depth under timbers of 18 ins. The method of installing the crossing was to jack up the tracks 2 ft. at crossing, supporting the traffic on timbers spanning the concrete, which was allowed to set before track was lowered to grade.

In June, 1907, a new crossing with concrete foundations was put in at the B. & O. Ry. crossing at Grosvenor, O., where an interlocking plant is maintained, with a crossing angle of 85°. The crossing was an ordinary rolled steel filled crossing, 85-lb. Am. Soc. C. E. rail. At that crossing there is a daily average of 50 trains on both railways, 12 of them being passenger trains. On account of the grades and alinements, trains run at a high rate of speed over this crossing. Considerable trouble was experienced after about twelve months by the concrete cracking from around timbers; the bolts in the crossing became loose and had to be tightened about three times per week, on account of the rail of frogs wearing into the timbers, and to the maintenance of the surface either side, the crossing became low and gave a very bad riding track.

After repairing the concrete footing and renewing bolts the bad surface at crossing and loose bolts returned, so therefore, after 18 months, in December, 1908, the concrete was torn out, ties were put in diagonally, crushed limestone ballast was placed under frogs and adequate subdrainage provided. The crossing is no longer giving more trouble than could be expected.

The results of a flat crossing on concrete foundation is illustrated at Dana, W. Va., where the Campbell's Creek Coal Co. Ry. crosses the K. & M. Ry. at angle of 30° 30'. The present crossing an ordinary 90-lb. Am. Soc. C. E. rail was put in new in September, 1907. Traffic over the crossing averages 40 trains per day at slow speed with no interlocking. In March, 1908, four of the rails in the K. & M. Ry. track had to be renewed on account of the ends at point becoming badly battered down. At the time it was thought the rails were defective, but at the present time the same trouble has been experienced, necessitating the replacing of five more of these frog rails. The fault, therefore, is due to the rigid bearing of the concrete, causing heavy blows on the points of the frogs, which are about 8 ins. apart. The life of this crossing has been very short, about 18 months. On account of the slow speed of trains not much trouble has been had with loose bolts, failure of concrete or bad surface. It is proposed to leave the concrete for the foundation in and to renew frogs with a hard center crossing, which should give good results.

In every case where interlocking plants are maintained and trains go at full speed over the crossing, the frogs are badly worn and hard to maintain. Where interlocking plants are not maintained and crossing is 90°, and trains of necessity go slow over the frogs, the crossings are holding up in good shape and are easy to maintain.

The following conclusions of concrete foundations for crossings may be made:

1. The concrete gives too rigid a bearing under frogs, causing an anvil blow at frogs which soon wears down the points, especially at flat crossings, on account of the greater distance between points.

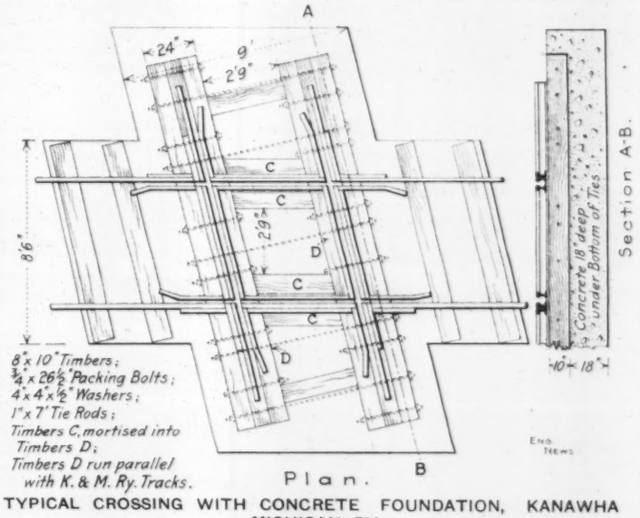
2. This anvil or solid blow is hard on bolts, especially when high speed is maintained over frogs.

3. In a high speed track concrete cracks away from timbers on account of the excessive jar.

4. It is hard to maintain a good surface on the track, as the concrete footing does not permit of raising.

5. The rigid bearing is hard on equipment.

6. The concrete foundation for crossing is a failure. The only case where it can be used to good advantage is where traffic is light, speed low and angle of crossing 90° more or less.




TYPICAL CROSSING WITH CONCRETE FOUNDATION, KANAWHA MICHIGAN RY.

AN INCREASE IN CHARGES FOR IRRIGATING water under the projects of the U. S. Reclamation Service has been found necessary in several instances, owing to recent increased cost of construction which has prevailed throughout other parts of the country as well as the West. The Secretary of the Interior has issued a public notice stating that the charges under the Minidoka Project in Idaho will be increased from $22 per acre to $30 per acre of irrigable land for construction costs of irrigation works, and from 40 to 60 cts. per acre for operation and maintenance. The construction costs are payable in ten annual instalments, if desired. Under the Umatilla Project in Oregon, the rates on the land to be put under irrigation the coming season have been fixed at $60 per acre for construction costs and at $1.30 per acre for operating and maintenance charges.

*Division Engineer, Kanawha & Michigan Ry. Co., Charleston, W. Va.

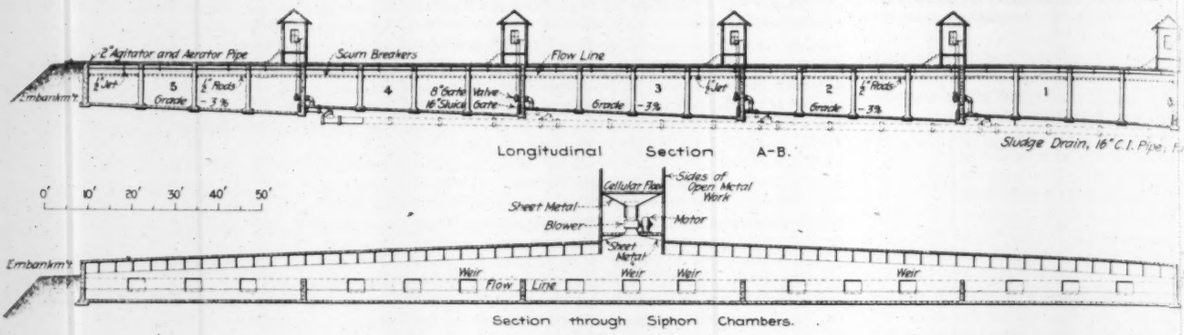
# Sewage Purification Works at Mt. Vernon, N. Y.

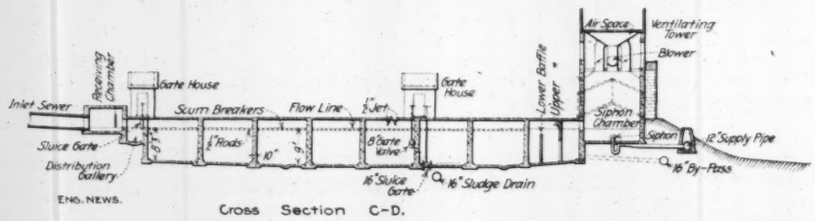
By GEO. L. ROBINSON,* Assoc. M. Am. Soc. C. E.

The sewage disposal plant now under construction for the city of Mt. Vernon, N. Y., contains in its design some unique features incident to the location of sewage-treatment works in the neighborhood of a built-up section of the city.

The sewage of the city at present discharges into the Hutchinson River, by gravity, through three main trunk sewers. The sewage from a section of the city sloping towards the Bronx Valley (perhaps 8% of the whole) is intercepted and lifted to the main trunk sewer by means of pumps.

The site selected for the disposal plant is on property owned by the city, and leaves available



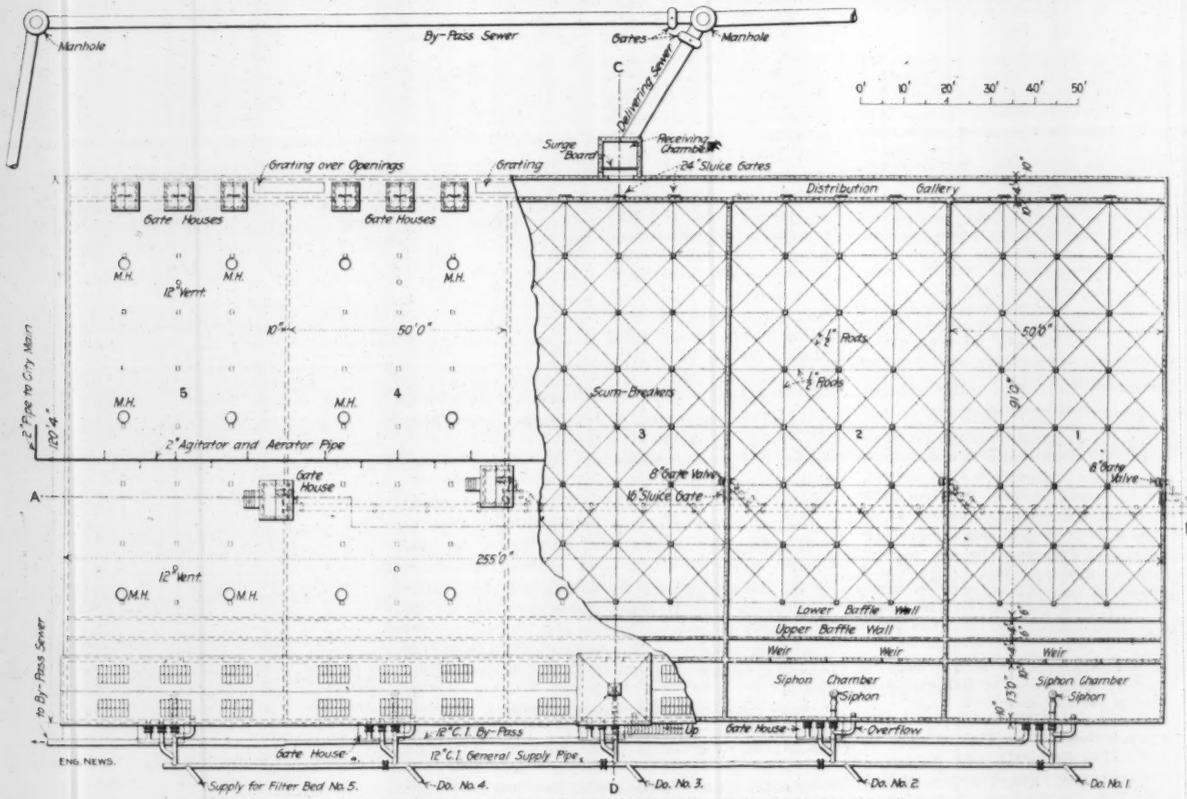




FIG. 1. SEWAGE SEDIMENTATION BASINS, MT. VERNON, N. Y.

Mt. Vernon is located in Westchester County, about thirteen miles north of New York. The area of the city is 2,600 acres, or about 4 sq. mi. It is distinctly a residential community of house owners, of an exceptionally desirable class of citizens, and the city itself contains practically no manufacturing plants. In 1907 the estimated population of the city was 28,000, which indicates an increase at the present rate to a population of 50,000 in 1935.

*President New York Sewage Disposal Co., 1 Madison Ave., New York City.

13½ acres, the plot being conveniently located in the southeasterly section adjoining the Hutchinson River.

The sewage is of a purely domestic character. Gagings of the flow indicate that there is at this time approximately 2,800,000 gals. a day, as a maximum. It was found necessary to rearrange slightly some of the sewers to bring all but a small percentage of the sewage to the plant by gravity.

The plant will consist of a receiving chamber, a distributing gallery, five sedimentation basins with automatic intermittent siphon chambers, the necessary pipe connections, and six downward-jet sprinkling filters. The sewage will arrive at a receiving chamber, approximately 8 ft. sq., provided with manhole openings, etc. Across the top of the roof will be a system of water piping, connected with the city supply. This will be adjusted in such a manner that six or more ½-in. pipes will pierce the concrete roof, and extend

of all the settling basins. It will be approximately 4 ft. wide and 250 ft. long. The sewage will enter each one of the five settling-basin units from the distribution gallery by means of three 24-in. openings in the walls. The openings will be controlled by movable weirs, which can be raised or lowered, giving a control over the flow into each of the five tanks, or shutting off one or more absolutely.

SETTLING BASINS.—The flow line in the settling basin at the entrance weir is at Elev. 32.0. Each basin will be 50 × 100 ft., × 8½ ft. (average) deep. The basins (Fig. 1) will be built of concrete, with sloping floors, giving an average depth of 8½ ft. throughout, with a maximum of 10 ft. The concrete is reinforced with corrugated metal bars. The walls will be 10 ins. thick and the roof will be composed of 6-in. slabs, provided with manhole openings, etc. Across the top of the roof will be a system of water piping, connected with the city supply. This will be adjusted in such a manner that six or more ½-in. pipes will pierce the concrete roof, and extend

down... a point within 1 ft. of the water level ... tanks. These pipes will be controlled ... ves and will make possible the discharge ... stream of water into the surface of the ... low, thereby creating agitation and the ... tion of a considerable amount of the ... oxygen ... is deemed desirable, as it will break up any ... formation.

The ... of the settling basin will be supported ... nes of columns of reinforced concrete extending ... own the length of each basin, there being ... lumns in each basin, spaced 12½ ft. c. to c., extending from column to column at right ... s and diagonally, and also to the walls from the ... olumns, will be set in ½-in. galvanized wrought-iron rods at Elev. 31.5. As the siphon chamber discharges and fills it produces a rise and fall in the sewage surface of the settling tank. Thus any scum formation will be broken apart by passing upward and downward over these rods. It has been found that there is a tendency in tanks of this kind to form a grease seal unless the surface is subjected to some agitation.

Two draw-off gates are provided for each tank: one an 8-in. gate near the middle zone, and the other a 16-in. sluice gate at the bottom, for the removal of sludge. These connect directly with a 16-in. cast-iron sludge pipe leading to the sludge bed beyond. The tanks are provided with baffle walls near the outlet end, one extending upward from the floor beneath and one downward from the roof. At the outlet end is a weir in which will be set an automatic "overhead siphon," working in conjunction with an automatic sewage-discharging siphon set in the siphon chamber. The siphon chamber for each tank is 50 ft. long and 8 ft. wide, providing a discharge draft for the siphon therein contained, of approximately 2¼ ft. The arrangement is such that when the water reaches Elev. 32.0 ft., the main siphon in this chamber discharges, together with 6 ins. of water over the entire surface of the settling basin. The discharge from the settling basin ceases when the level of the weir of the overhead siphon is reached, though the discharge from the siphon chamber continues until it is empty, thereby producing a period of absolute rest for the sprinkling beds beyond.

The next discharge does not take place until the settling basin has been filled 6 ins. and the siphon chamber filled to the point of discharge from which it originally started. In this way a series of discharges is brought about, producing a condition of alternate spraying of the beds. Each siphon chamber is provided, in addition, with valves so that the siphon control can be cut out and the beds beyond operated on a constant head. Over the siphon chambers will be built a roof to collect any gases which may develop at this point. This roof will extend over all of the siphon tanks and in the center will be mounted a motor and fan, so that the air and gas may be drawn upward and blown through a series of filters consisting of commercial iron oxide. These filters are arranged in a tower (Fig. 2), so that the sulphuretted hydrogen will be eliminated as it passes through the iron oxide on its way upward.

This point was considered a very important one, as the neighborhood in which the disposal plant is being constructed is one which will ultimately become built up with valuable residences.

SPRINKLING FILTERS.—The six sprinkling filters (Fig. 3) are each 50 ft. wide and 210 ft. long. The walls are built of concrete, approximately 16 ft. high, 8 ins. thick at the top and 12 ins. thick at the bottom, reinforced with metal. The roof will consist of steel trusses of sufficient weight and strength to carry a wooden roof, with two lines of skylights, and the weight of the iron distribution pipes and nozzles, which will be suspended therefrom.

The system of distribution will consist of a 12-in. pipe leading from the siphons, a main 20-in. distribution pipe and two 8-in. pipes from the main distributing pipe extending the full length of each bed. From these will extend 4-in. laterals to supply the jets. There will be approximately 50 jets to each bed, set about 10½ ft. c. to c. The jets will discharge in the form of streams, which fall approximately 4 ft., striking a splasher plate which will distribute the effluent in the form of rain over the filter material. These plates are to be made of glass, as it affords a smoother and better material than metal.

It is estimated that each nozzle will deliver approximately 5.8 gals. per min., and it is proposed to have a series of orifices arranged so that the actual working of the plant may be governed by the size of jet necessary.

The splash plates will be supported on galvanized iron standards. These standards are so arranged that they may be adjusted either laterally or perpendicularly, after being set. The sprinkler beds will be underdrained on the bottom by a 12-in. carrier of vitrified pipe, laid with open joints, the bell pulled well back, so as to permit ready inflow of the effluent. There will be lateral underdrains of 12-in. half-pipe. In addition, the lower layer of material will consist of 18 ins. of large broken stone placed by hand in such a way that they form a false bottom. All the sewers and drains will slope in the direction of the main collector. Above the drainage pipe and stone will be placed 5 ft. of 1 to 1½-in. broken stone.

It is proposed to cover the surface of the bed with 4 ins. of selected gravel in order to retard the flow of the spray when it first reaches the surface of the bed, and to bring about a little wider distribution of the drops.

The roofs over these sprinklers are so arranged that at the gable end a flue of sufficient size will enter and draw therefrom the unpleasant odors developed. This flue will lead to a second gas filter tower, which will be approximately 25 ft. sq., and contain six floors of filters of iron oxide. A flue from each bed will connect to the central station and platform. It is estimated that the fan will be capable of discharging about 25,000 cu. ft. of air per min., if necessary.

After leaving the sprinkler beds the effluent will pass to a sedimentation basin, a concrete structure approximately 20 × 200 ft., × 4 ft. deep. The function of this sedimentation basin is to permit the subsidence of any suspended matter not contained in the effluent. From this basin the effluent will pass directly into the Hutchinson Creek.

The sludge chamber, in which the sludge is dried, will be a circular tank, approximately 75 ft. in diameter by 8 ft. deep. The bottom of this tank will be filled in for 2 or 3 ft. with broken stone, upon which will be placed about 2 ft. of locomotive cinder. The function of this structure will be to allow of the removal of heavy organic matter which resists decomposition in the settling basins, and to permit the drying out and removal of the water therefrom, so that the sludge may be removed and properly disposed of. There will be a secondary tank, approximately 25 ft. in diameter, so arranged that the effluent may be treated chemically before being discharged into the creek, if such treatment is necessary.

Provision is made for the extension of the whole plant to double the size now under construction.

The plans for these works were prepared by Mr. John M. Farley, M. Am. Soc. C. E., and the writer. The Bunting-Bull Co., 1 Madison Ave., New York City, is the contractor for the plant.

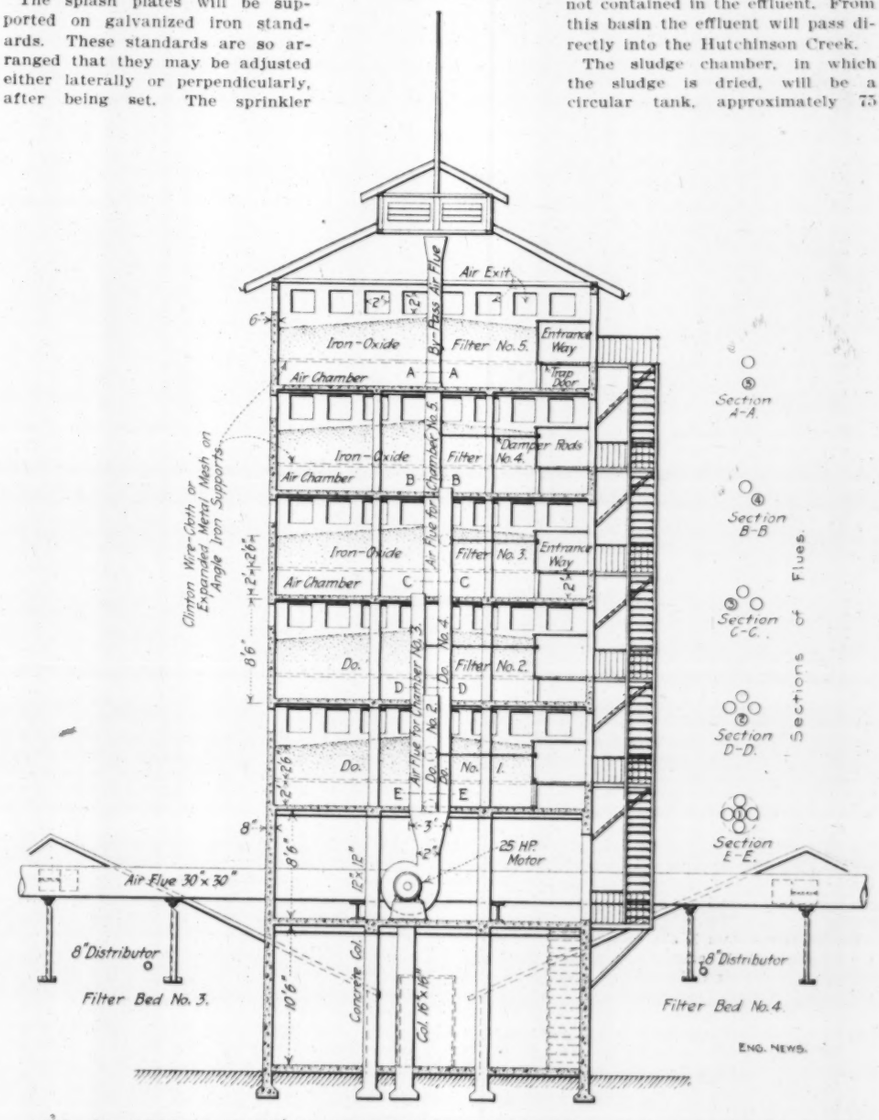



FIG. 2. SECTION THROUGH VENTILATING TOWER AND GAS FILTERS, MT. VERNON SEWAGE PURIFICATION WORKS.

# An Analysis of Highway Traffic in Rhode Island.*

By ARTHUR HORACE BLANCHARD,† Assoc. M. Am. Soc. C. E.

The variability in the nature of the traffic to which suburban and country highways are subjected demands a careful analysis if economic and efficient construction and maintenance are to be characteristic of the work of highway engineers in the future.

Prior to the entrance of the motor car as an important integral element of highway traffic, the classification of highways and the consequent determination of the kind of surface adapted to that traffic and the efficient maintenance of the same were, to a certain extent, understood. Due to the fact that the only appreciable decrease in the amount of horse-drawn vehicle traffic has been caused by the partial substitution of the motor car for pleasure vehicles and cabs, the problem has not been changed materially in the case of city streets, excepting those built of macadam. On the other hand, the traffic to which many suburban and country highways are subjected has radically changed during the past five years.

The primary factors in the analysis of traffic are the actual and relative amounts of horse-drawn vehicle traffic and motor car traffic and the speed at which the motor cars traverse the highways.

In an analysis of highway traffic it is obviously necessary to adopt a more or less detailed classification as a working basis. During 1908 the engineers of the State Board of Public Roads of Rhode Island used the following classification:

Motor car traffic:
- Runabouts
- Touring cars, four or five seats.
- Touring cars, six or seven seats, including limousines and landaulets.
- Motor cycles.

Horse-drawn vehicle traffic:
- Commercial traffic—
  - One-horse wagon, loaded, iron tires.
  - One-horse wagon, loaded, rubber tires.
  - One-horse wagon, unloaded, iron tires.
  - One-horse wagon, unloaded, rubber tires.
  - Two-horse wagon, loaded, iron tires.
  - Two-horse wagon, loaded, rubber tires.
  - Two-horse wagon, unloaded, iron tires.
  - Two-horse wagon, unloaded, rubber tires.
  - Other wagons, loaded.
  - Other wagons, unloaded.
- Pleasure vehicle traffic—
  - One-horse vehicle, iron tires.
  - One-horse vehicle, rubber tires.
  - Two-horse vehicle, iron tires.
  - Two-horse vehicle, rubber tires.

The primary concepts governing the differentiation of highway traffic into the various classes upon which the following tables are based will be briefly explained.

The radical difference in the character of the wear of a macadam surface by horse-drawn vehicle traffic and motor car traffic does not require a detailed explanation. Nevertheless, it is advisable to emphasize the important difference, namely, that even high-speed motor car traffic does not cause abrasion, while heavy horse-drawn vehicle traffic does wear the macadam surface in appreciable amount. Again, granted average climatic conditions on a New England highway, for example, whose macadam surface is well bonded together, a rapid disintegration will be caused by high-speed motor car traffic while horse-drawn vehicle traffic may more or less improve the same surface. The raison d'etre, therefore, for the initial division of traffic under the headings, motor car traffic and horse-drawn vehicle traffic is apparent.

The various divisions of motor car traffic are based upon a classification, depending upon the fact that the disintegration of a macadam surface caused by this class of traffic is a function of the two closely related variables, weight and speed.

The sub-division of horse-drawn vehicle traffic into commercial and pleasure traffic is advisable primarily on account of the difference in weight imposed on the surface of the road by the two classes of traffic. The further sub-division of each of the above classes depends mainly on two facts: (1) That wear caused by the impact of the hoofs of horses necessarily varies directly with the number of horses, and (2) that weight per square inch of the tire on the road surface likewise varies, although not directly, with the number of draft animals. The division of the various classes enumerated under commercial traffic into loaded and unloaded vehicles is dependent on the variation in weight. The final sub-division of all classes of horse-drawn vehicle traffic into vehicles with iron tires and those with rubber tires depends on the fact that the former causes infinitely more abrasion than the latter under similar conditions.

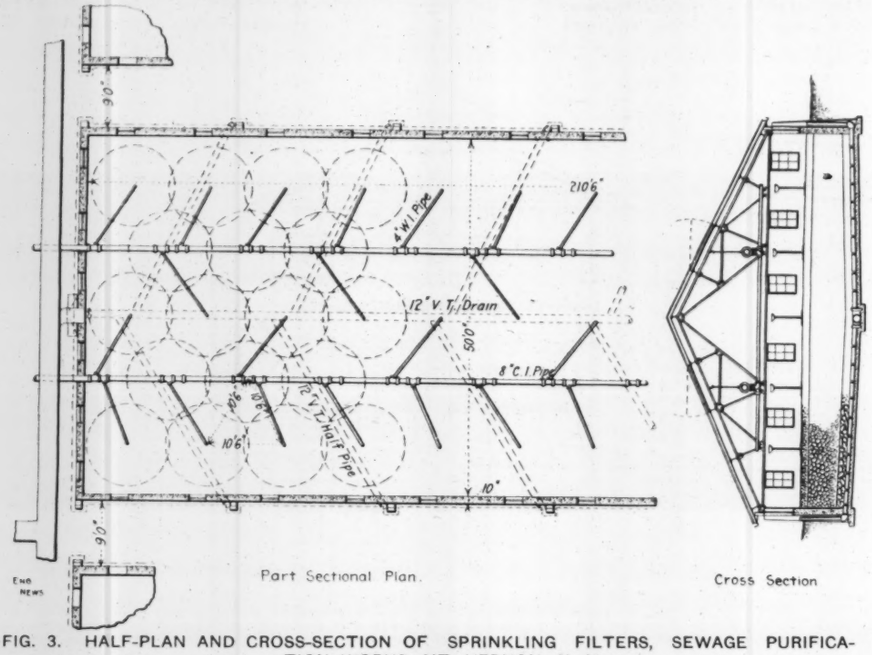



FIG. 3. HALF-PLAN AND CROSS-SECTION OF SPRINKLING FILTERS, SEWAGE PURIFICATION WORKS, MT. VERNON, N. Y.

In this brief paper the traffic on seven typical highways in Rhode Island will be analyzed and discussed. The following descriptions of the various roads selected cover the essential characteristic features viewed from the standpoint of highway traffic and the effect of the same on the road surface.

The East Providence 1906 road is a part of the interstate trunk line connecting the cities of Providence and Fall River and an intrastate trunk line passing through many towns and summer resorts. The surface was built of local stone, consisting of a mixture of chlorite gneiss and indurated sandstone. Continuous repairs have been necessary to prevent disintegration.

The East Providence 1907 road is a part of the same trunk line as the 1906 road. It is subjected to the traffic to three popular summer amusement resorts in addition to the traffic on the 1906 road. The surface was built of bituminous macadam with the surface of the No. 2 course sealed by painting with coal tar or Texaco asphalt. The surface is in perfect condition at present.

The Narragansett 1907 road is a part of the interstate trunk line connecting Boston, Providence, Narragansett Pier, and New York. The surface was built of bituminous macadam without a sealed surface. The road is in perfect condition, while sections of ordinary macadam adjacent to this section have rapidly disintegrated.

The South Kingstown 1905 road is a part of the interstate trunk line connecting New York, Narragansett Pier, Newport, Providence and Boston. The surface was built of local granite. It has required continuous repairs in order to prevent the rapid disintegration of the surface

TABLE II.—TRAFFIC ON THE EA[illegible] PROVIDENCE 1907 AND NARRAGANSETT 19[illegible] ROADS FROM 10 A. M. TO 10 P. M., JULY 19, 1[illegible]

| | E. Provi[illegible] 1907 Ro[illegible] | Narragansett 1907 Road. |
|---|---|---|
| Motor car traffic: | | |
| Runabouts | 109 | 63 |
| Touring cars— | | |
| 4-5 seats | 211 | [illegible] |
| 7 seats, limousines, landaulets | 29 | [illegible] |
| Motor cycles | 31 | 35 |
| | | 2 |
| Total motor car traffic | 380 | 342 |
| Horse-drawn vehicle traffic: | | |
| Commercial traffic: | | |
| One-horse wagons— | | |
| Loaded, I. T. | 24 | 1 |
| R. T. | 1 | |
| Unloaded, I. T. | 36 | |
| R. T. | 1 | |
| Two-horse wagons— | | |
| Loaded, I. T. | | |
| R. T. | | |
| Unloaded, I. T. | | |
| R. T. | 1 | |
| Other wagons— | | |
| Loaded, I. T. | | |
| R. T. | | |
| Unloaded, I. T. | | |
| R. T. | 1 | |
| Pleasure vehicle traffic: | | |
| One-horse vehicles, I. T. | 51 | 15 |
| R. T. | 103 | 14 |
| Two-horse vehicles, I. T. | 1 | |
| R. T. | 19 | |
| Total horse-drawn vehicle traffic | 238 | 30 |
| Total traffic | 618 | 372 |

TABLE I.—TRAFFIC ON SEVEN RHODE ISLAND HIGHWAYS FOR EIGHT CONSECUTIVE HOURS.*

| | East Providence 1906 | East Providence 1907 | Narragansett 1907 | South Kingstown 1905 | Warwick 1906 | Coventry 1905 | Lincoln 1907 |
|---|---|---|---|---|---|---|---|
| Motor car traffic: | | | | | | | |
| Runabouts | 39 | 86 | 61 | 25 | 84 | 12 | 19 |
| Touring cars— | | | | | | | |
| 4 seats | 155 | 157 | 162 | 101 | 159 | 9 | 18 |
| 7 seats, limousines, landaulets | 8 | 23 | 23 | 23 | 49 | .. | .. |
| Motor cycles | 10 | 21 | 20 | .. | 6 | 1 | .. |
| Total motor car traffic | 212 | 287 | 266 | 149 | 289 | 22 | 37 |
| Horse-drawn vehicle traffic: | | | | | | | |
| Commercial traffic— | | | | | | | |
| One-horse wagons—Loaded—I. T. | 4 | 16 | 1 | 2 | 11 | 27 | 49 |
| R. T. | .. | .. | .. | .. | .. | .. | .. |
| Unloaded—I. T. | 15 | 14 | .. | 11 | 4 | 87 | 29 |
| R. T. | .. | .. | .. | .. | .. | .. | .. |
| Two-horse wagons—Loaded—I. T. | .. | .. | .. | 4 | .. | 25 | 6 |
| R. T. | .. | .. | .. | .. | .. | .. | .. |
| Unloaded—I. T. | .. | 1 | .. | 4 | .. | 10 | 11 |
| R. T. | .. | .. | .. | .. | .. | .. | .. |
| Other wagons—Loaded I. T. | .. | .. | .. | .. | .. | 1 | .. |
| R. T. | .. | .. | .. | .. | .. | .. | .. |
| Unloaded—I. T. | .. | .. | .. | .. | .. | 1 | .. |
| R. T. | .. | .. | .. | .. | .. | .. | .. |
| Pleasure vehicle traffic: | | | | | | | |
| One-horse vehicles, iron tires | 13 | 38 | 10 | 8 | 21 | 67 | 5 |
| Rubber tires | 21 | 98 | 6 | 4 | 42 | 7 | .. |
| Two-horse vehicles, iron tires | .. | 1 | .. | 1 | 1 | .. | .. |
| Rubber tires | 2 | 13 | .. | .. | 4 | .. | .. |
| Total horse-drawn vehicle traffic | 55 | 181 | 17 | 34 | 83 | 225 | 100 |
| Total traffic | 267 | 468 | 283 | 183 | 372 | 247 | 137 |

*In the case of the Narragansett 1907 and South Kingstown 1905 roads the period was from 10 a. m. to 6 p. m.; on the East Providence 1906, East Providence 1907, and Warwick 1906 roads the period was from 2 p. m. to 10 p. m. The period for the other highways was from 8 a. m. to 4 p. m.

*A paper read before Section D of the American Association for the Advancement of Science, at the Baltimore Meeting, December, 1908.

†Associate Professor of Civil Engineering, Brown University; Deputy Engineer, State Board of Public Roads of Rhode Island.

TABLE III.—TRAFFIC ON EAST PROVIDENCE 1907 ROAD, SUNDAY, AUG. 30, 1908, 8 A. M. TO 10 P. M.

| | A. M. 8-9 | 9-10 | 10-11 | 11-12 | P. M. 12-1 | 1-2 | 2-3 | 3-4 | 4-5 | 5-6 | 6-7 | 7-8 | 8-9 | 9-10 | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Motor car traffic: | | | | | | | | | | | | | | | |
| Runabouts | 3 | 4 | 5 | 2 | 6 | 8 | 5 | 13 | 7 | 13 | 15 | 18 | 6 | 7 | 112 |
| Touring cars— | | | | | | | | | | | | | | | |
| 4-5 seats | 3 | 5 | 11 | 12 | 10 | 9 | 17 | 20 | 16 | 33 | 28 | 17 | 10 | 8 | 199 |
| 7 seats, limousines, landaulets | .. | .. | 2 | 2 | .. | 2 | 2 | 1 | 2 | 1 | .. | 1 | 2 | 1 | 16 |
| Motor cycles | .. | 2 | .. | 1 | 7 | 6 | 2 | 6 | 8 | 3 | .. | 1 | .. | .. | 36 |
| Total motor car traffic | 6 | 11 | 18 | 17 | 23 | 25 | 26 | 40 | 33 | 50 | 43 | 37 | 18 | 16 | 363 |
| Horse-drawn vehicle traffic: | | | | | | | | | | | | | | | |
| Commercial traffic— | | | | | | | | | | | | | | | |
| One-horse wagons—Loaded—I. T. | 3 | .. | 2 | 4 | 5 | 1 | 3 | 1 | 1 | 2 | 7 | 15 | 3 | 3 | 50 |
| R. T. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| Unloaded—I. T. | 3 | 4 | 4 | 3 | 3 | 1 | .. | 1 | .. | 1 | .. | .. | .. | .. | 20 |
| R. T. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| Two-horse wagons—Loaded—I. T. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | 2 |
| R. T. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| Unloaded—I. T. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| R. T. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| Other wagons — Loaded—I. T. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| R. T. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| Unloaded—I. T. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| R. T. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| Pleasure vehicle traffic— | | | | | | | | | | | | | | | |
| One-horse vehicles—Iron tires | 2 | 2 | 4 | 4 | 4 | 3 | 6 | 7 | 10 | 12 | 20 | 10 | 2 | 5 | 91 |
| Rubber tires | .. | 1 | 6 | 4 | 4 | 11 | 15 | 21 | 27 | 28 | 27 | 18 | 7 | 3 | 172 |
| Two-horse vehicles—Iron tires | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| Rubber tires | .. | .. | .. | .. | 1 | .. | .. | .. | 5 | .. | .. | .. | 1 | .. | 7 |
| Total horse-drawn vehicle traffic | 9 | 7 | 16 | 15 | 16 | 16 | 24 | 31 | 38 | 43 | 60 | 43 | 12 | 12 | 342 |
| Total traffic | 15 | 18 | 34 | 32 | 39 | 41 | 50 | 71 | 71 | 93 | 103 | 80 | 30 | 28 | 705 |

The Warwick 1906 road is a part of the same interstate trunk line as the Narragansett 1907 road. Due to its location near Providence it is a part of several intrastate trunk lines passing through thickly-settled districts. The surface was built of trap rock from Meriden, Conn. Continual ravelling and disintegration requires constant repairing.

The Coventry 1903 road is a part of an interstate trunk line passing through the central western part of Rhode Island and into Connecticut. At present about five miles remain uncompleted, hence the highway is practically a feeder to a typical country district of 70 sq. mi. The surface was built of trap rock from Meriden, Conn. Due primarily to ravelling, frequent repairs are necessary.

The Lincoln 1907 road is a part of an intrastate trunk line passing through a series of mill towns terminating in the city of Providence. The surface was built of local granite. The surface is in good condition, only ordinary repairs being necessary.

Table I. contains a record of the traffic on the highways described above for a period of eight continuous hours. It was the intent to select normal periods for the various sections which would place them all on the same basis considering their location and the traffic to which they are subjected.

Tables II. to V. are described by their respective titles. In every case cited the traffic records are given for normal conditions.

The conclusions to be drawn from the records contained in Table I., taken in conjunction with the status of the macadam surfaces of the various sections referred to, are as follows:

(1) The amount of motor car traffic which will cause disintegration is much less than is generally supposed, as is shown by the amount and the effect of the traffic on the South Kingstown 1905 road.

(2) In the case of two roads subjected to practically the same amount of motor car traffic, the rate of disintegration will depend upon the location of the road, other conditions being equal. For instance, the rate of disintegration of the South Kingstown 1905 road is more rapid than in the case of the East Providence 1906 road, the former being located in an isolated district, the latter in the near vicinity of the city of Providence.

(3) The rate of disintegration of an ordinary macadam surface will vary almost directly as the percentage of motor car traffic. As examples of the above conditions the Coventry 1905 road and Warwick 1906 road, both built of trap rock, and the Lincoln 1907 and the South Kingstown 1905 roads both built of local granite are cited.

(4) The popular belief that trap rock is the ideal road material for the surface of all macadam roads independent of the nature of the traffic to which they are subjected is a fallacy. In the case of roads subjected to horse-drawn vehicle traffic consisting of pleasure and light commercial traffic, as for example, the Coventry 1905 road, or subjected to motor car traffic, either exclusively or in combination with light horse-drawn vehicle traffic, as for example, the Warwick 1906 road, the trap rock surface is exceedingly expensive to maintain. This is due to the fact that very little dust is furnished by abrasion on account of the hardness of the broken stone, and hence, the binder being absent, the surface ravels under horse-drawn vehicle traffic or is disintegrated by motor car traffic.

(5) Bituminous macadam roads require a sealed surface when the highway traffic consists of a combination of heavy motor car traffic and heavy horse-drawn vehicle traffic, while the sealed surface is not a requisite when the road is subjected to only heavy motor car traffic. The East Providence 1907 road is an example of the first class of bituminous macadam roads, while the Narragansett 1907 road is characteristic of the second class. The sealed surface is considered necessary for the first class as insurance against the disintegration of the surface due to the liability of the loosening of the exposed No. 2 stone by blows from the hoofs of horses and the rapid enlargement of any break in the surface by motor car traffic.

Table II. shows a more marked comparison between the two roads than Table I.

Tables III., IV. and V. have been included in this paper to show the actual distribution of traffic throughout the day and the improbability of being able to effectually control the speed of motor cars, especially in isolated districts, except by an extensive organization of state police.

TABLE IV.—TRAFFIC ON EAST PROVIDENCE 1907 ROAD, FRIDAY, AUG. 28, 1908, 8 A. M. TO 6 P. M.

| | A. M. 8-9 | 9-10 | 10-11 | 11-12 | P. M. 12-1 | 1-2 | 2-3 | 3-4 | 4-5 | 5-6 | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Motor car traffic: | | | | | | | | | | | |
| Runabouts | 7 | 4 | 4 | 3 | 4 | 2 | 4 | 7 | 8 | 3 | 46 |
| Touring cars— | | | | | | | | | | | |
| 4-5 seats | 15 | 9 | 8 | 4 | 8 | 11 | 21 | 13 | 25 | 13 | 127 |
| 7 seats, landaulets, limousines | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| Motor cycles | .. | .. | 1 | 2 | .. | .. | 2 | 1 | 1 | 1 | 8 |
| Total motor car traffic | 22 | 13 | 13 | 9 | 12 | 13 | 27 | 21 | 34 | 17 | 181 |
| Horse-drawn vehicle traffic: | | | | | | | | | | | |
| Commercial traffic— | | | | | | | | | | | |
| One-horse wagons—Loaded—I. T. | 11 | 19 | 16 | 8 | 2 | 8 | 9 | 8 | 13 | 8 | 102 |
| R. T. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| Unloaded—I. T. | 2 | 5 | 4 | 2 | 3 | 7 | 5 | 3 | 4 | 3 | 38 |
| R. T. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| Two-horse wagons—Loaded—I. T. | 5 | 9 | 2 | 3 | 1 | 1 | 2 | 3 | 4 | 6 | 36 |
| R. T. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| Unloaded—I. T. | .. | 2 | .. | .. | 2 | 1 | .. | 4 | .. | 3 | 12 |
| R. T. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| Other wagons — Loaded—I. T. | 1 | .. | .. | 1 | .. | 1 | .. | .. | .. | .. | 3 |
| R. T. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| Unloaded—I. T. | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | 1 |
| R. T. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| Pleasure vehicle traffic— | | | | | | | | | | | |
| One-horse vehicles—Iron tires | 5 | .. | .. | .. | 3 | 1 | 3 | 3 | 5 | 1 | 21 |
| Rubber tires | 2 | 3 | 1 | .. | .. | .. | 2 | 7 | 7 | .. | 22 |
| Two-horse vehicles—Iron tires | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| Rubber tires | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| Total horse-drawn vehicles | 26 | 38 | 23 | 14 | 11 | 19 | 21 | 29 | 33 | 21 | 235 |
| Total traffic | 48 | 51 | 36 | 23 | 23 | 32 | 48 | 50 | 67 | 38 | 416 |

TABLE V.—TRAFFIC ON NARRAGANSETT 1907 ROAD, SUNDAY, JULY 19, 1908, 10 A. M. TO 10 P. M.

| | A. M. 10-11 | 11-12 | P. M. 12-1 | 1-2 | 2-3 | 3-4 | 4-5 | 5-6 | 6-7 | 7-8 | 8-9 | 9-10 | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Motor car traffic: | | | | | | | | | | | | | |
| Runabouts | 5 | 2 | 9 | 4 | 4 | 5 | 6 | 18 | 3 | 4 | 2 | 1 | 63 |
| Touring cars— | | | | | | | | | | | | | |
| 4-5 seats | 2 | 19 | 20 | 19 | 26 | 26 | 30 | 28 | 31 | 13 | 6 | 2 | 222 |
| 7 seats, limous., landaulets | .. | 4 | 3 | 1 | 1 | 3 | 11 | 10 | 13 | 7 | 1 | 1 | 55 |
| Motor cycles | .. | .. | .. | 1 | .. | .. | 1 | .. | .. | .. | .. | .. | 2 |
| Total motor car traffic | 7 | 25 | 32 | 25 | 31 | 34 | 48 | 56 | 47 | 24 | 9 | 4 | 342 |
| Horse-drawn vehicle traffic: | | | | | | | | | | | | | |
| Commercial traffic— | | | | | | | | | | | | | |
| One-horse wagons— | | | | | | | | | | | | | |
| Loaded — I. T. | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | .. | .. | 1 |
| R. T. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| Unloaded—I. T. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| R. T. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| Two-horse wagons— | | | | | | | | | | | | | |
| Loaded — I. T. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| R. T. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| Unloaded—I. T. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| R. T. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| Other wagons— | | | | | | | | | | | | | |
| Loaded — I. T. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| R. T. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| Unloaded—I. T. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| R. T. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| Pleasure vehicle traffic— | | | | | | | | | | | | | |
| One-horse vehicles— | | | | | | | | | | | | | |
| Iron tires | 1 | 1 | 2 | .. | 1 | 3 | 3 | 2 | 1 | 1 | .. | .. | 15 |
| Rubber tires | .. | 1 | 2 | .. | 2 | 2 | 1 | 3 | 1 | 1 | 1 | .. | 14 |
| Two-horse vehicles— | | | | | | | | | | | | | |
| Iron tires | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| Rubber tires | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |
| Total horse-drawn vehicle traffic | 1 | 2 | 4 | .. | 4 | 5 | 4 | 5 | 2 | 2 | 1 | .. | 30 |
| Total traffic | 8 | 27 | 36 | 25 | 35 | 39 | 52 | 61 | 49 | 26 | 10 | 4 | 372 |

A ROLLER RELIEF BEARING has been designed to lighten load on plain journal bearings. It is not considered safe to use the regular roller bearing for such duty, for example, as main engine journals. This relief bearing does not replace the plain journal but supplements it by carrying a certain amount of the load.

The bearing is in the form of a roller which is pushed by a spring against the side of the shaft at a point close beside the journal to be relieved. The direction of pressure is chosen so as to directly oppose the resultant of the flywheel weight and belt pull. The following description of the roller is taken from an article in the "American Machinist," March 18, 1909:

The friction relief bearing is made up of a cast-iron housing, a central main roll pin which is stationary in the housing and an outer steel roll. Between the main roll and the main roll pin are 16 rolls, eight in a cage upon each end of the housing. At each end of the main roll are eight hardened steel balls. These balls bear upon two hardened steel washers, one at each end, and take care of the end thrust in the main roll. The smaller intermediate rolls have also at each end a hardened steel washer which takes the end thrust. The main roll pin is hollow, is partially filled with felt and forms an oil reservoir which lubricates the inside of the bearing. One end of this main roll is provided with a series of holes and a stop pin which permits the oil tube to stand vertical no matter what the position of the roll.

The main rolls are so proportioned that their length is about equal to their diameter, and they are manufactured in three sizes to carry respectively maximum loads of 2,000, 4,000 and 8,000 lbs. The mechanism which holds the roll against the shaft is a "tiller rod" near one end of which is attached the roller housing. The other end is pivoted at any convenient point of support and the spring acts through a second rod applied to the extreme end of the tiller beyond the housing so as to get the maximum leverage. The pressure of the spring may be adjusted to any desired value up to the limit for which the roller is designed.

This device is manufactured by the Pickering Governor Co., Portland, Conn.

## Baldwin 213-Ton Articulated Locomotive for Southern Pacific Ry.; the Heaviest Locomotive Ever Built.

The Baldwin Locomotive Works recently completed two freight locomotives of unprecedented weight and size for use on the heavy grades of the Sacramento Division of the Southern Pacific Ry. These locomotives, one of which is shown in the half-tone Fig. 1, are of the Mallet articulated type, are compounded as usual in this type, and are fitted for burning oil.

Their weight exceeds that of the heaviest existing Mallets by about ten tons, or say 5%. While therefore they do not form a radical departure in type or weight, they contain some notable details of construction, among them two striking innovations: (1) The boiler contains a *feedwater heater*, besides an intermediate superheater, and (2) the boiler is *separable* at a bolted joint about midway of its length, at the front of the boiler shell proper. This last feature enables the whole engine to be cut in two lengthwise, with but little labor or time, so that in the repair shop, for example, the two parts can be handled separately. The engine must be dead, of course, before it can be cut apart, and all the piping between front and rear half must be disconnected, unions being built into the pipes for this purpose.

WHEEL DIAGRAM.—The general construction of this engine is exhibited by the elevation and cross-sections in Fig. 2. Each of the two sections has four coupled axles, the front section has a two-wheel leading truck and the rear section has a two-wheel trailing truck. This keeps the wheel-loads relatively moderate. The load on drivers (394,150 lbs.) averages 24,600 lbs. per wheel, while the load on truck wheels averages 7,250 and 8,600 lbs. per wheel for front and rear truck respectively. These figures are lower than found in the heaviest Consolidation freight engines and in some passenger locomotives, where the wheel-loads reach 30,000 lbs.

ARTICULATION.—As usual in the Mallet type, the frame of the rear section is the main frame, the boiler being fastened to it rigidly. It carries the high-pressure cylinders at its forward end, on either side of the frame, just abreast of the main saddle. The front frame is pivoted and carries the low-pressure cylinders. It is connected to the main frame by a vertical pin on the longitudinal center line of the engine between the high-pressure cylinders. This pin enables the front frame to swing laterally, and correspondingly the boiler supports on the front frame are arranged so as to be free to slide laterally. The tractive effort generated in the front frame is transmitted through the pin. Vertical load, however, is not transmitted across the hinge, but any necessary vertical equalizing action is secured by a mortise-and-tenon connection between the abutting ends of the frames. The drawing Fig. 3 shows both the pin articulation and the tenon connection.

BOILER SUPPORT.—The boiler has five points of support on the frames, two on the front frame and three on the main frame. One of the five is a fixed support, this being the saddle at the high-pressure cylinders, just over the articulation of the frames (Fig. 3). The two supports to the rear of this are sliding shoes under the firebox, which allow for the longitudinal expansion. They are held in lateral guides, however, and the guides have lips extending over the sliding shoe, so that each bearing is rigid laterally and also hooks the boiler and frame together vertically.

The two bearings on the forward frame, being required to permit of lateral sliding, are detailed as simple sliding supports, without guides. In each, the lower member is formed by the flat upper surface of a frame tie or cross-beam, while the upper member is a flat plate recessed into the lower face of a saddle which carries the boiler. The front one of the two bearings has in addition a pair of centering springs, acting on a cross-rod mounted on lateral extensions of the frame cross-beam. These springs exert a curve-guiding action, since whenever the forward frame is deflected by a curve they bring lateral pressure to bear on the boiler (and through it upon the main frame) tending to turn it into the curve. Without the springs, of course, the flange-pressure on curves would be borne almost wholly by the first pair of drivers in the rear frame.

This spring-centered bearing is detailed in Fig. 5. The other bearing is closely similar, without the springs. Both bearings have vertical plates bolted to the frame tie, with the upper edge bent over at right angles hooking over the flange of the saddle plate. These prevent the boiler lifting off the frame, as would otherwise happen when lifting the locomotive by crane in the shop.

FRAME.—The frame differs materially in its cross-connections from the form of construction ordinarily used in locomotives. The cylinders are bolted on outside the frames, and have no function as frame members.

At the high-pressure cylinders the main boiler bearing forms a strong cross-connection at the top of the side frames, while the lower bearing of the pin ties the bottom rails of the frames together. The pin jaw-piece or radius-bar at the same time forms a cross-tie for the rear end of the forward frames (see Fig. 3). The other four boiler supports also act as frame ties for the upper rails of the side-frames. Additional connections at the top of the frame are given by the guide-yokes which carry the crosshead guides of low-pressure and high-pressure engines respectively, etc. The two crossties on the rear frame are tied to the boiler by vertical transverse diaphragms of steel plate, which brace the frame laterally and also carry a part of the weight of the boiler. At several points narrow bottom ties are introduced to stiffen the lower rails of the frames.

The forward frame is secured at the front to a large box-shaped casting, outside of which the low-pressure cylinders are bolted. The back end of the casting is [illegible] side-frames, while its front end ca[rries] plate casting with the buffer bea[m] is cored out to form a steam passa[ge] pressure supply. The pipe carryin[g] steam from the superheater in [the] enters the rear of the casting, wh[ere] passes through the cored-out pas[sage] openings in the top of the casting, [one] side. A short elbow-casting conn[ects] these openings with the side of th[e] This arrangement is shown compl[etely] diagrammatically, by Fig. 4.

BOILER.—The novel construction [of] is shown by the drawing Fig. 7, [in] the forward part only. The rear [part] boiler proper, 21 ft. long in the tu[be] of this the shell forms a chamber 7[2] ins. long, the combustion chamber. This is fi[tted] with a manhole at the top. A length of 6[2] ins. in front of the combustion chamber is utiliz[ed] as feed-water heater. This has longitudina[l] tubes, of exactly the same size, number and a[rrangement] as in the boiler, but is stayed by through bolts above the tubes, in place of the angle stays used in the boiler.

In front of the feed heater is a long smoke-box, in which is placed a superheater of well-known form. This is not a superheater in the ordinary meaning, however, since the steam supplied to the high-pressure engine does not pass through it; it may be called a reheater. The high-pressure exhaust enters its forward end, and the reheated steam passes from its rear end through a flexible pipe to the low-pressure cylinders.

BOLTED SEPARABLE JOINT IN BOILER.—The novelty of a separable joint in the boiler is made possible by the presence of the vacant space of the combustion-chamber between boiler and feed heater. Near the rear end of this chamber the shell is cut by a complete transverse joint. A forged ring is riveted to the outside of the shell on either side of the joint. The abutting faces of these rings fit together with a flat V-shaped tongue-and-groove fit, and longitudinal bolts through the rings hold the joint together.

The rear support of the boiler on the forward frame is located just ahead of the joint. When the joint is disconnected, the pin which connects the frames removed and all longitudinal pipes disconnected (they are fitted with unions for this purpose), the two frames become entirely independent and can be moved around the shop separately. Disconnecting the joint in the boiler is a simple operation, requiring only that the lagging over the joint be removed and the 42 1¼-in. bolts of the joint unscrewed. The separable feature was tested by the builders before the engine left the shop, and was found entirely workable.

The feed to the boiler is forced into the feed heater by two non-lifting injectors under the cab. The feedwater heater is kept constantly

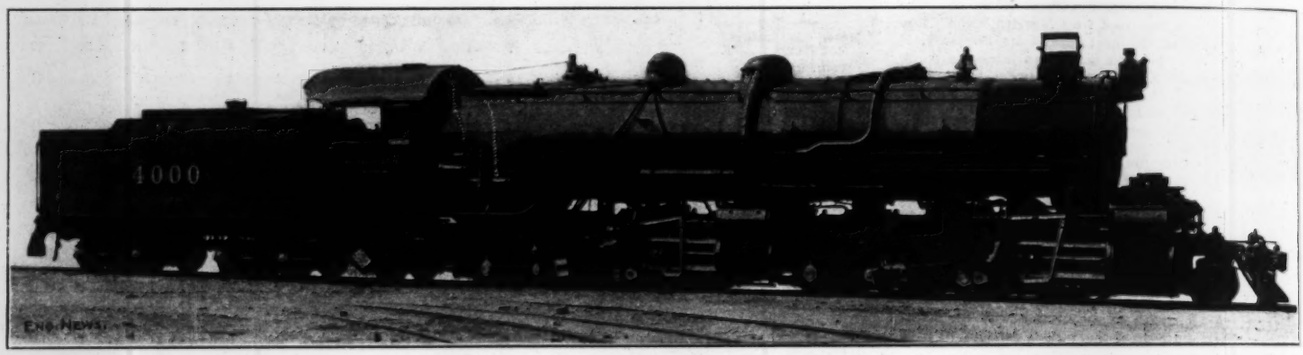


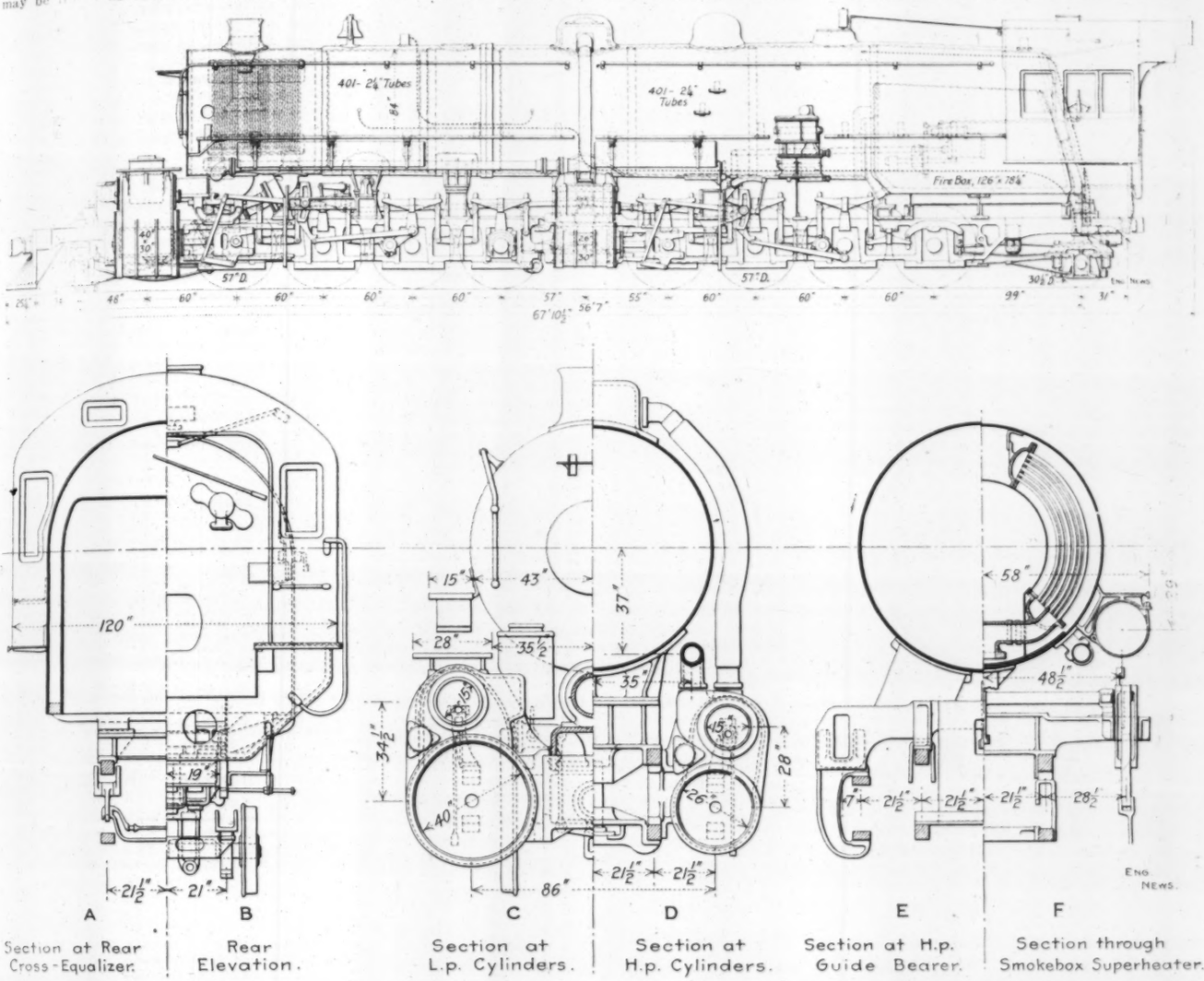

FIG. 1. ONE OF THE NEW MALLET COMPOUNDS BUILT FOR FREIGHT SERVICE ON THE SOUTHERN PACIFIC RY.
Built by Baldwin Locomotive Works, Philadelphia, Pa.
(Weight of Engine, 426,000 lbs.; Engine and Tender, 596,000 lbs. Oil-burning. Cylinders, 26 × 30 and 40 × 30 ins.)

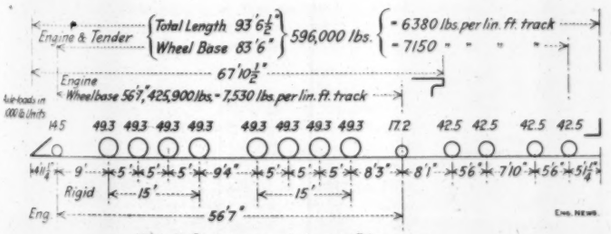
full, and [illegible]ow of fresh water forces warm water ou[illegible]h a pipe leading out of the top of the sh[illegible]heck-valves placed right and left in the s[illegible]e boiler proper.

STEAM.—The course of the steam may be t[illegible]as follows: The dome, made of cast-steel (see Fig. 7), is seated on the boiler in the same transverse plane as the high-pressure cylinders. On either side of the dome a pipe passes out and down along the shell to the high-pressure valve chests. This arrangement is the same as used in previous engines of this type. The exhaust from the high-pressure cylinders passes into a pipe on either side leading forward along the boiler to the front end of the smoke-box, where it turns in and discharges into the front header of the superheater (or reheater). The superheater consists of six coils from front to back, connected by headers alternating at top and bottom; each coil comprises several rows and embraces three layers of pipe on either side (see section F, Fig. 2). The total heating-surface of the superheater is 655 sq. ft. The rear bottom header is formed by a T-piece connecting both sides of the superheater, and has an opening downward, to which the low-pressure steam pipe is attached. This is a flexible pipe and leads downward and forward, discharging into the steam chamber in the box-casting which connects the front end of the frames. The steam goes through this chamber and out at openings in its top, whence short cast elbows lead it into the two low-pressure valve chests. The exhaust opening is in the front wall of the valve-chest, and here the exhaust pipe is attached. These pipes turn inward and at the center line of the locomotive again turn backward, coalescing into a single pipe which extends back to a point under the stack and turns up into the exhaust nozzle.

The low-pressure steam and exhaust pipes are the only parts of this system that are affected by the lateral flexibility of the frame. Both are therefore fitted with ball-and-socket joints at either end and a slip joint in the middle. Fig. 6 gives the construction of these pipes. The high-pressure exhaust pipes (leading forward to the superheater) are provided with a slip joint made tight by means of a packed gland. This joint makes the pipe easily separable, and allows for heat expansion.

This steam system is supplemented by a live-steam connection from the boiler to the low-pressure steam chamber, controlled by a hand valve as will be noted farther on.





Engine & Tender { Total Length 93'6½" / Wheel Base 83'6" } 596,000 lbs. { = 6380 lbs. per lin. ft. track / = 7150 " " " " }
Engine 67'10½"
Wheelbase 56'7", 425,900 lbs. = 7,530 lbs. per lin. ft. track
Driving Wheels
14.5 49.3 49.3 49.3 49.3 49.3 49.3 49.3 49.3 17.2 42.5 42.5 42.5 42.5
14½" 9' 5' 5' 5' 9'4" 5' 5' 5' 8'3" 8'1" 5'6" 7'10" 5'6" 5½"
Rigid 15' 15'
Eng 56'7"
Eng. News.

Wheel Spacing and Load Diagram.

FIG. 2. GENERAL ELEVATION AND SECTIONS, 426,000-LB. MALLET FREIGHT LOCOMOTIVE FOR SOUTHERN PACIFIC CO.

ENGINES.—The cylinders are of 26 ins. diameter by 30 ins. stroke, and 40 ins. diameter by 30 ins. stroke, respectively. The low-pressure cylinders are said to be the largest ever put on a locomotive. They make the extreme width of the machine nearly 11 ft.

Both pairs of cylinders have piston valves, 15 ins. diameter, 5½ ins. travel. They are set with 5/16 in. lead, and have a steam lap of 1-in. and an exhaust clearance of 1/16-in. The valve gear is of the Walschaert type. The links are hung outside the driving-wheels.

For starting, steam can be admitted to the low-pressure cylinders by a hand-operated valve in the cab, and this is shut off by hand after starting. No automatic simpling valve is provided. The auxiliary steam pipe controlled by the starting valve is of small diameter, so that if the valve should be left open when the engine is under way the cylinder action would be interfered with but little.

The reverse mechanism is worked by compressed air. The mechanism is indicated by dotted lines in Fig. 2 and the air cylinder is separately shown by Fig. 8. The pilot valve is moved by a rod shifted by a latched lever in

the cab, and is returned to mid-position by a connection to the piston-rod of the air cylinder.

As the reach rod must connect both engines it requires a flexible joint to follow the lateral movements of the front frame. This joint is so arranged that it comes vertically over the main hinge-pin when in mid-position, so that the movement of the frame has only vanishingly small distorting influence on the valve motion of the forward engine. This arrangement has been patented.

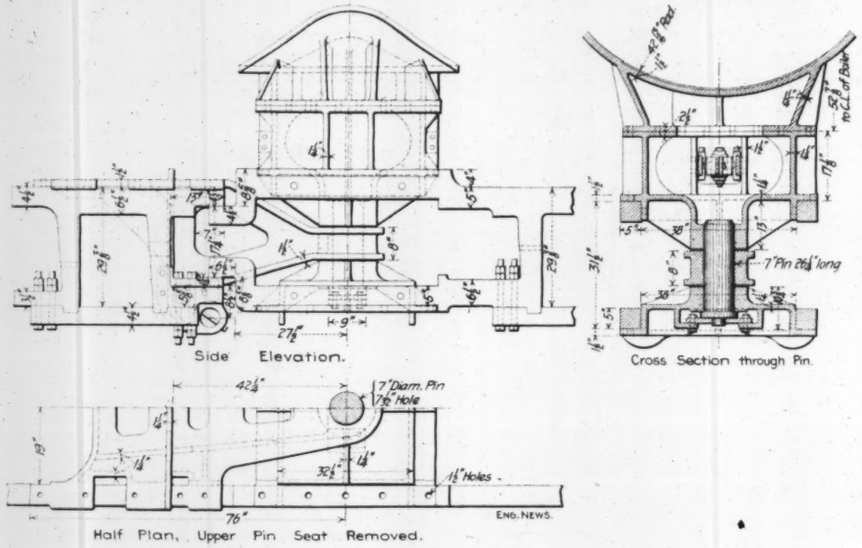



FIG. 3. ARTICULATION OF FRAMES IN SOUTHERN PACIFIC MALLET LOCOMOTIVE.
(Detail of frames and boiler support at front end of main frame.)

The location and arrangement of the joint may be seen from the cross-section at the high-pressure cylinders, Fig. 3. The saddle casting which carries the boiler has a central longitudinal passage cored in it, and guide bars are bolted to the sides of this passage. A crosshead sliding on these guides has the rear and front sections of the reach rod pinned to it, and thus forms the knuckle of the rod. This knuckle being guided both laterally and vertically, the reach rod has only longitudinal stress. To reduce as far as possible the force required to move the reverse lever, the reverse shafts are so connected to the radius rods that one link-block rises while the other falls, a partial counterbalance.

FIREBOX.—These locomotives are fitted for burning oil. A steel pan closes off the bottom of the firebox, and the oil injector is located at its front end. Air inlets in the front of the pan adjoining the injector are covered by a damper, raised or lowered by a lever in the cab. The firebox is otherwise the same as would be used for coal fuel, and may be adapted to this purpose by substituting a grate and ashpan for the present pan. The tender is arranged to correspond. The oil tank occupying the space ordinarily used for coal is independent and can be lifted out for changing to coal fuel.

TRUCKS AND WHEELS.—The engine truck wheels and the tender wheels are "Standard" solid forged and rolled steel wheels. The tender trucks have cast-steel side frames, with journal boxes bolted in.

The engine trucks are fitted with cast-steel bolsters, and obtain their loading through an equalizer lever, connected with the last driving-box equalizer. In the case of the rear truck the loading point is a cross-tie between the main side-frames, under the rear end of the firebox. The front truck takes its load from the box-casting between the low-pressure cylinders. The front truck, moreover, has a single central equalizer, while the rear truck has two equalizers. The front truck is thus center-bearing, and the rear truck side-bearing. The cross-section A in Fig. 2 shows the cross equalizer beam of the rear driving-box springs, with seats for the two longitudinal equalizers. The latter have their fulcrum or load-point on double-pin brackets on a cross-tie of the frame (see side-elevation in Fig. 2), and their rear ends rest on links which are pinned to the truck-bolster. The bolster is connected to the truck by laterally swinging hangers, which have a double-pin bearing so as to lift the load slightly as the truck swings. In the case of the front truck, the swing hangers have single pins. Both front and rear truck bolsters are guided laterally by vertical projections fitting into the front footplate and rear frame tie respectively.

OTHER DETAILS.—A number of minor features of interest are noted in these locomotives. The cylinder drain cocks are operated by compressed air. The low-pressure cylinders are oiled by a mechanical oil pump operated from the valve gear; the high-pressure cylinders, on the other hand, are oiled by a sight-feed lubricator placed in the cab. There are three sand-boxes, one being placed on top of the boiler, and two just ahead of the boiler between the low-pressure cylinders. All are pneumatic. The front sand-boxes supply the front group of driving wheels.

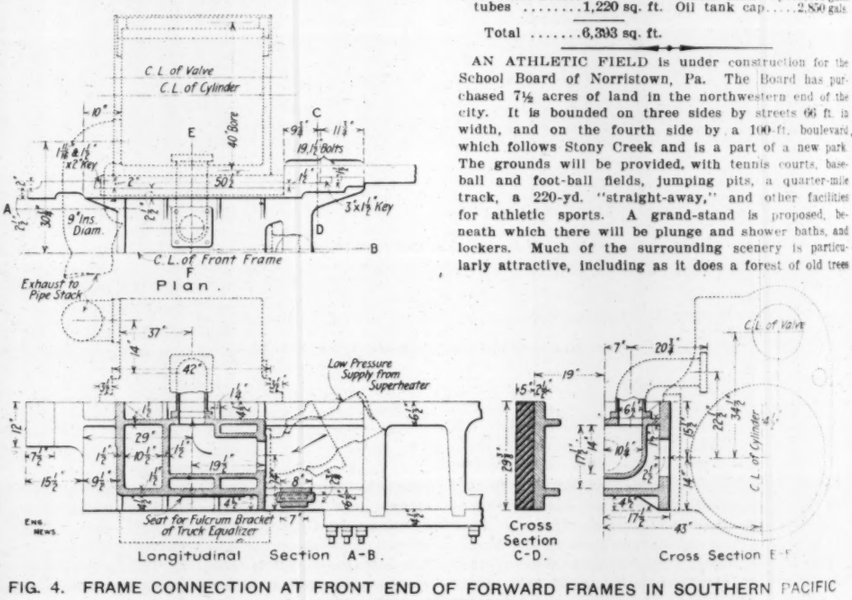



FIG. 4. FRAME CONNECTION AT FRONT END OF FORWARD FRAMES IN SOUTHERN PACIFIC MALLET LOCOMOTIVE.
(Diagrammatic sketch of location of low pressure cylinders and steam piping between reheater and exhaust nozzle.)

A peculiar feature of the ex... of the locomotive is the smo... the stack, as may be seen in F... V-shaped casting, set point do... over the stack. The deflector ... yoke hinged to the stack, and ... down out of the way when d... of smoke and steam issuing f... split and deflected to right a... snowsheds this protects the roof ... smoke to the ventilating openin... the side walls. This detail as w... of others were fixed in accordan... Pacific standard practice.

The two engines differ in that ... made of vanadium steel, those o... ing ordinary (carbon) steel. Thi... the unprecedented dimensions of t... makes their future performance ... much interest.

These engines are to be used on t... Sacramento Division, between Roseville and Truckee, Cal. The maximum grade on this divi...n is 116 ft. per mile. Each engine is rated at 1,212 tons, exclusive of engine and tender (the calculated tractive effort is 94,640 lbs.). Their chief dimensions given by the builders are tabulated below.

BALDWIN 430,000-LB. MALLET ARTICULATED FREIGHT LOCOMOTIVES FOR SOUTHERN PACIFIC CO.

| | |
|---|---|
| Gage (std.) | 4 ft. 8½ ins. |
| Cylinders | 26 & 40 × 30 ins. |
| Valves | Balanced Piston |
| **BOILER (Steel).** | |
| Diameter | 84 ins. |
| Thickness | 18/16 & 27/32-in. |
| Working pressure | 200 lbs./in.² |
| Fuel | Oil |
| Staying | T-crown bars |
| Fire-tubes, 401—2¼ ins. dia. × 21 ft.; thickness of metal | 0.125-in. |
| **FIREBOX (Steel).** | |
| Length | 126 ins. |
| Width | 78¼ ins. |
| Depth, front | 75½ ins. |
| Depth, back | 70½ ins. |
| Thickness of sheets, sides, back & crown | ⅜-in. |
| tube | ½-in. |
| Water spaces | 5 ins. |
| Grate area | 68.4 sq. ft. |
| **FEEDWATER HEATER.** | |
| Length | 63 ins. |
| Tubes, 401 | 2¼ ins. dia. |
| **HEATING SURFACE.** | |
| Firebox | 232 sq. ft. |
| Fire-tubes | 4,941 sq. ft. |
| Feedwater heater tubes | 1,220 sq. ft. |
| Total | 6,393 sq. ft. |
| Smokebox superheater | 655 sq. ft. |
| **WHEELS.** | |
| Driving (16) | 57 ins. O. Dia. 50 ins. I. Dia. |
| Main journals | 11 × 12 ins. |
| Other journals | 10 × 12 ins. |
| Truck (4) | 30½ ins. Dia. |
| Journals | 6 × 10 ins. |
| Tender (8) | 33½ ins. Dia. |
| Journals | 6 × 11 ins. |
| **WHEELBASE.** | |
| Driving | 39 ft. 4 ins. |
| Rigid | 15 ft. |
| Total engine | 56 ft. 7 ins. |
| Total engine and tender | 83 ft. 6 ins. |
| **LENGTH.** | |
| Over all | 93 ft. 6½ ins. |
| **WEIGHT.** | |
| On drivers | 394,150 lbs. |
| On front truck | 14,500 lbs. |
| On back truck | 17,250 lbs. |
| Total engine | 425,900 lbs. |
| Total engine and tender | 596,000 lbs. |
| **TENDER.** | |
| Water tank cap. | 9,000 gals. |
| Oil tank cap. | 2,850 gals. |

AN ATHLETIC FIELD is under construction for the School Board of Norristown, Pa. The Board has purchased 7½ acres of land in the northwestern end of the city. It is bounded on three sides by streets 66 ft. in width, and on the fourth side by a 100-ft. boulevard, which follows Stony Creek and is a part of a new park. The grounds will be provided, with tennis courts, baseball and foot-ball fields, jumping pits, a quarter-mile track, a 220-yd. "straight-away," and other facilities for athletic sports. A grand-stand is proposed, beneath which there will be plunge and shower baths, and lockers. Much of the surrounding scenery is particularly attractive, including as it does a forest of old trees on the borders of the field and a view to the westward of the Valley Forge hills. A site has been reserved for a school building which will soon be needed in this part of the city. Mr. John H. Crankshaw is chairman of the Building Committee of the School Board; Mr. S. Cameron Corson, Borough Engineer of Norristown, is consulting engineer for the work of developing the field; and Mr. Harry P. Hiltner is engineer in charge of construction, with Messrs. W. H. Jefferson and George H. Hitchcock as assistants.

## Power Costs in a 1,250-KW. Central Station.

By H. S. KNOWLTON.*

The following figures of electrical energy cost of the four years for the plant of the Quincy Electric Light and Power Co., have been calculated from the returns of the company as filed with the Massachusetts Gas and Electric Light Commission. Throughout this period the plant has been a purely reciprocating-engine station. Its normal-load capacity in 1905 was 450 KW. In 1906 an engine-driven 800-KW. set was added. During these years the cost of manufacturing electricity at the station switchboard has ranged between 1.702 cts. and 1.423 cts. per KW.-hr.

In 1905 the equipment of the station consisted of two 200-HP. water-tube boilers, carrying a steam pressure of 120 lbs. per sq. in. In 1905, three firemen were required. The prime movers consisted of two engines: one 12 × 22 × 30-in. horizontal, cross-compound, condensing, running at 150 r.p.m., direct connected to a 150-KW. alternator, and a 16 × 30 × 30-in. engine of the same type, running at 150 r.p.m., direct-connected to a 300-KW. alternator. The town streets were lighted by a constant-current system, with "tub" transformers in the station. The engine-room work in 1905 required the services of three engine men. The machinery was housed in a brick station 104 ft. long by 80 ft. wide.

The total energy generated in the plant in the year 1905 was 931,766 KW. The average load on the station throughout the year, based on a 24-hour day, was 106.5 KW., and the load factor (ratio of average yearly load to the normal station capacity) was 23.7%. This year the company sold a power output of 54,307 KW.-hrs. The total cost of generating, exclusive of any fixed charges on the plant and its equipment, for the fiscal year ending June 30, 1905, was approximately as in Table I. It should be noted that the amounts of coal are only approximate, but that the actual fuel costs are in accordance with filed returns.

*23 Richardson St., Newton, Mass.

TABLE I.—QUINCY STATION COST OF PRODUCTION, 1905.

| | |
|---|---|
| Output, KW.-hrs. | 931,766 |
| Costs: | |
| Coal, Cumberland, 1,480 tons, at $3.97 } | $6,573.60 |
| Coal, screenings, 349 tons, at $2.00 } | |
| Oil and waste | 652.51 |
| Water | 698.29 |
| Wages at station | 5,247.14 |
| Repairs of the station building | 827.23 |
| Repairs of steam machinery and equipment | 1,032.83 |
| Repairs of electrical equipment in station | 000.00 |
| Station tools and appliances | 60.00 |
| Total | $15,091.60 |
| Costs per KW.-hr.: | |
| Fuel | .705 cts. |
| Labor | .563 |
| Repairs | .200 |
| Miscellaneous | .150 |
| Total | 1.618 cts. |

TABLE II.—QUINCY STATION COST OF PRODUCTION, 1906.

| | |
|---|---|
| Output, KW.-hrs. | 1,174,395 |
| Costs: | |
| Coal, Cumberland, 1,760 tons, at $3.76 } | $8,468.62 |
| Coal, screenings, 786 tons, at $2.37 } | |
| Oil and waste | 710.50 |
| Water | 998.35 |
| Wages at station | 5,286.43 |
| Repairs of station building | 468.45 |
| Repairs steam machinery and equipment | 760.46 |
| Repairs of electrical equipment in station | 23.46 |
| Tools and appliances | 000.00 |
| Total | $16,716.27 |
| Costs per KW.-hr.: | |
| Fuel | .721 cts. |
| Labor | .450 |
| Repairs | .107 |
| Miscellaneous | .145 |
| Total | 1.423 cts. |

In 1906, the company added two 300-HP. water-tube boilers and an 800-KW. alternator, direct connected to a 22 × 48 × 48-in. Cooper-Corliss, horizontal, cross-compound condensing engine running at 100 r.p.m. The total boiler capacity was thus raised to 1,000 HP. and the total engine capacity to 1,690 HP. An oiler was added to the engine-room force in this year, the number and positions of the other employees remaining the same as in the preceding year. The station output was 1,174,395 KW.-hrs., of which 108,862-KW.-hrs. were sold in a large block for power. The total cost of generating was made up as shown in Table II.

In 1907 the total output of the station was 1,281,961-KW.-hrs. The company's block-power sales aggregated 166,372-KW.-hrs. The equipment in the boiler and engine rooms remained the same as in 1906 and the operating force was decreased by discharging the oiler. Table III. gives the cost of production for this year:

TABLE III.—QUINCY STATION COST OF PRODUCTION, 1907.

| | |
|---|---|
| Output in KW.-hrs. | 1,281,961 |
| Costs: | |
| Coal, Cumberland, 2,070 tons at $4.20 } | $10,581.35 |
| Coal, screenings, 944 tons, at $2.00 } | |
| Oil and waste | 1,041.73 |
| Water | 977.01 |
| Wages at station | 5,830.48 |
| Repairs of station building | 389.56 |
| Repairs of steam machinery and equipment | 2,902.08 |
| Repairs of electrical equipment in station | 78.06 |
| Tools and appliances for station service | 5.18 |
| Total | $21,806.05 |
| Costs per KW.-hr.: | |
| Fuel | .825 cts. |
| Labor | .455 |
| Repairs | .263 |
| Miscellaneous | .159 |
| Total | 1.702 cts. |

The same equipment was in service in the fiscal year ending June 30, 1908. The operating force was increased by the addition of one engineer and one fireman, making a total of four engineers and four firemen. Table IV. gives the cost of operation for the year.

TABLE IV.—QUINCY STATION COST OF PRODUCTION, 1908.

| | |
|---|---|
| Output in KW.-hrs. | 1,470,066 |
| Costs: | |
| Coal, Cumberland, 2,104 tons, at $4.75 } | $12,081.74 |
| Coal, screenings, 949 tons, at $2.13 } | |
| Oil and waste | 735.65 |
| Water | 1,005.11 |
| Wages at station | 6,844.65 |
| Repairs of station building | 791.05 |
| Repairs of steam plant machinery | 1,415.72 |
| Repairs of electrical equipment in station | 105.64 |
| Tools | 000.00 |
| Total | $22,979.56 |
| Costs per KW.-hr.: | |
| Fuel | .821 cts. |
| Labor | .465 |
| Repairs | .157 |
| Miscellaneous | .117 |
| Total | 1.560 cts. |

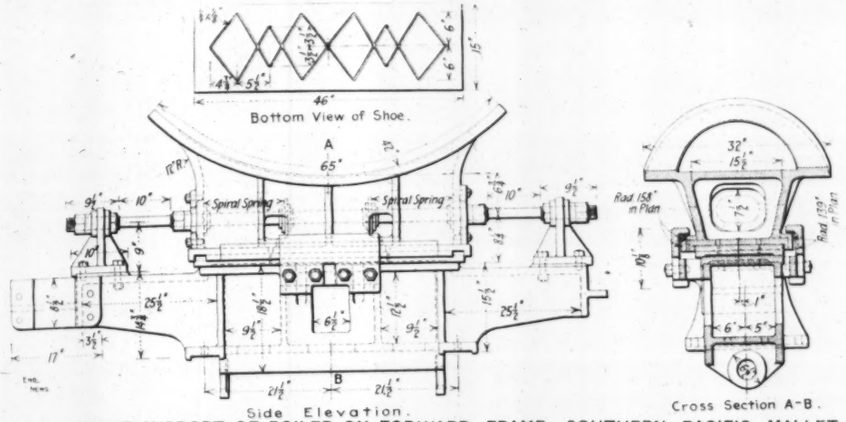



FIG. 5. FRONT SUPPORT OF BOILER ON FORWARD FRAME, SOUTHERN PACIFIC MALLET LOCOMOTIVE.

(The rear bearing on the forward frame is similar, but without centering springs.)

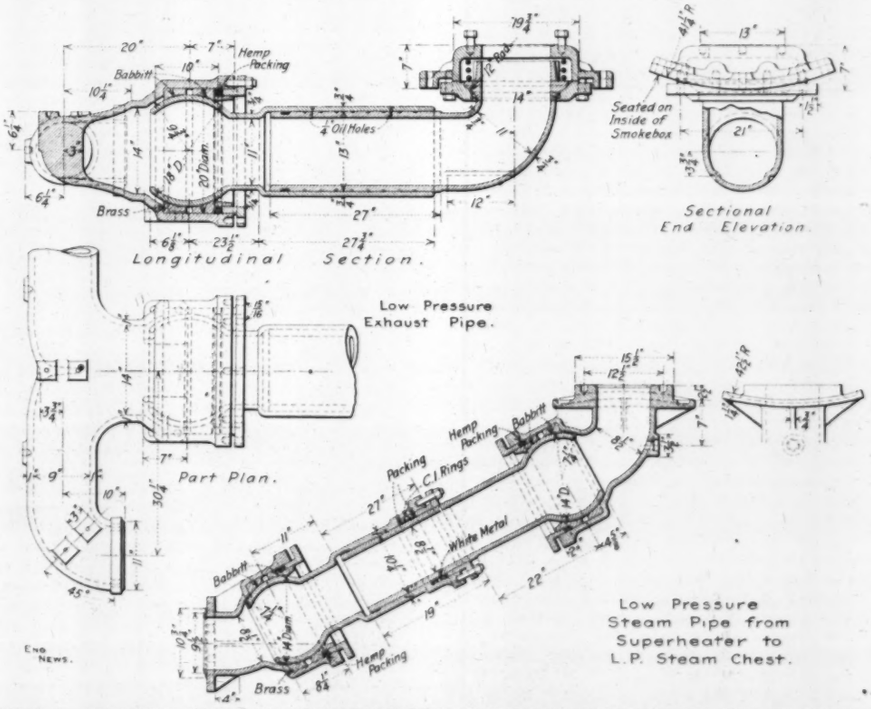
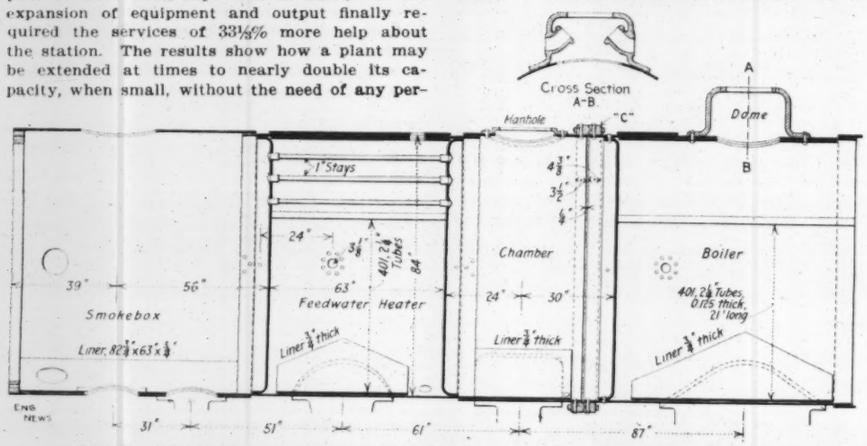



FIG. 6. FLEXIBLE PIPING OF LOW-PRESSURE ENGINE, SOUTHERN PACIFIC MALLET LOCOMOTIVE.

Reviewing the operation of the station as a whole during the four years it is evident that the plant has been handicapped by a considerable increase in the cost of its Cumberland coal, while the price of screenings has remained approximately the same. In spite of the increase in station capacity the labor requirements appear to have been kept well in hand, but the expansion of equipment and output finally required the services of 33⅓% more help about the station. The results show how a plant may be extended at times to nearly double its capacity, when small, without the need of any permanent additions to its payroll, and also how the progressive increase in the station load which follows a healthy growth in the community's demand for service will sooner or later require an addition to the operating force, even though the machinery of the installation remains unchanged. In figuring the labor requirements of a station both the plant capacity and the extent of the use of various units at different times must be considered. A station of large capacity often has been taken care of by one or two men when the equipment has been idle a considerable share of the time.



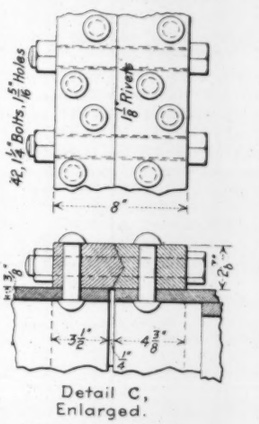




FIG. 7. LONGITUDINAL SECTION OF FRONT END OF BOILER, SOUTHERN PACIFIC MALLET LOCOMOTIVE.
(Shows location of feedwater heater and bolted joint in shell.)

## An Automatic Dredge.

An automatic dredge, which gets its power from the current of the river, is a recent invention of a Russian nobleman, the Baron Nicolas Tomini, who has used it with considerable success in leveling up the bottom of the River Volga on his own estates. The device was first exhibited at the International Maritime Exposition at Bordeaux in 1907, and is described in the Annales des Ponts et Chaussées, Nov.-Dec., 1908, No. 6, p. 146.

The purpose of the apparatus is to maintain a level channel bottom by moving the dirt from the high places into the low places. The underlying principle is the helical screw, composed of a central, horizontally disposed, shaft carrying, at a distance of anywhere from 20 to 50 ins. from the center, a helical cutting edge some 4 ins. wide and ⅛-in. thick. This edge is in a surface cylindrical to the center shaft and is joined thereto by an iron plate following the shape of the helix. The main shaft has at each end a swivel joint, so that the whole screw is free to turn and it is also possible to join several screws together longitudinally making, in some instances, a total length as much as 230 ft. In the opinion of the inventor there seems to be no reason why lengths of 500 or 600 ft. cannot be operated.

In operation the huge screw is made up on shore and rolled down to the place where the river bottom is to be leveled, where it is fixed in a general direction across the stream and each swiveled end fastened to some fixed point so that it is free to move up and down through a limited distance. As soon as the depth of water around it is sufficient the current causes it to revolve and in revolving the screw naturally bites in the earth at the high places and progressively carries it until it is deposited at the exit end of the screw, or drops it in the low places.

It is claimed that the device has been perfected so that it can be made to load earth into barges, but so far the only use to which it has been put has been in leveling up bottoms and moving earth from near banks or piers to the deeper mid-channel. The following figures are given as to its operation: In a Russian river with a current 1½ ft. per sec., work was commenced at a depth of water of 2 ins. and from 50 to 80 cu. yds. an hour was moved. On the Prépet River, in a stiff clay, it dug in two days a boat channel 5 ft. deep. At Kopatchi, in 100 hrs., a 230-ft. spiral established a channel 320 ft. long, 125 ft. wide and 4½ ft. deep. Before the dredging the depth varied from 7 ins. to 2 ft. The device, it is claimed, will move blocks and stones up to 120 lbs. in weight and will displace the roots and trunks of trees embedded in the river bottom.

The article from which this is taken contains a number of letters from engineers high in the Russian service testifying to the efficiency of the apparatus.

## Developments in Electrical Engineering During 1908.*

The general recession in business which has continued during the past year has given our engineers more time to devote to improvements and economies in the design of our various lines of apparatus and supplies.

Experience in the use of the high electric pressures of from 60,000 to 100,000 volts, needed for the economical distribution of electricity over very long distances, has been so satisfactory that higher pressures up to 150,000 volts are being considered in pending propositions. In this connection, it is an interesting fact [illegible] of transformers of 60,000 volts and over [illegible] nearly double those in 1907.

We have made many improvements in [illegible] the control of high tension circuits, and [illegible] and placed in commercial operation switches for controlling 110,000 volts, which is the highest now in practical operation.

Two of the 14,000-KW. turbines, mentioned in my last report, have been placed in operation in Chicago, and two in New York. These have proven satisfactory in every respect, and orders for additional units of the same size have been placed with us.

Our engineers have completed the design of a number of turbine generators for operation by low pressure or exhaust steam. The economic value of these machines is based upon the fact that steam turbines are much more efficient than steam engines in the lower range of steam pressures between atmospheric pressure and a good vacuum. Important turbines of this character have been designed up to 5,000 KW. capacity. It is expected that they will, by utilizing the exhaust steam from one of the existing engines, increase the capacity of the combined unit more than 40% with a substantial reduction in coal consumption.

We have adapted our steam turbine to the driving of centrifugal pumps and have sold to the city of San Francisco eight 750-HP. and four 600-HP. turbine pumps for a high-pressure water system. This is the first important application of steam turbines to this class of service.

Our 1,200-volt railway system has been further perfected and the installations already made have proved an unqualified success.

The 35 electric locomotives sold the New York Central for operation of its New York terminal and tunnel have made an unequaled record for reliability and low cost of maintenance, and we have just completed an order for 12 additional locomotives of similar design.

The electric locomotives sold the Great Northern Railway Company, for its Cascade Tunnel Division, have been completed and satisfactorily tested and shipped. They will be in operation this summer, and are notable as possessing the greatest tractive power of any electric locomotives built to date.

The vertical type of rotary converters of our design, mentioned in previous reports, has continued to give satisfaction and many additional installations have been made during the past year. They are of particular value because of the saving in space afforded by the compactness of design. We are building a number of these vertical rotaries of 2,500 KW. capacity, which are the largest rotaries ever constructed.

The Indiana Steel Co., at Gary, Ind., has started rolling rails by a rail mill of new design entirely driven by special electric induction motors of our manufacture. These are the largest induction motors ever designed, having an ultimate capacity in excess of 10,000 HP. each. The application of electric motors in this case effects considerable economies in the production of steel rails with increased output.

*From the Annual Report of the General Electric Co., Statement by E. W. Rice, Jr., Vice-President in Charge of Manufacturing and Engineering.

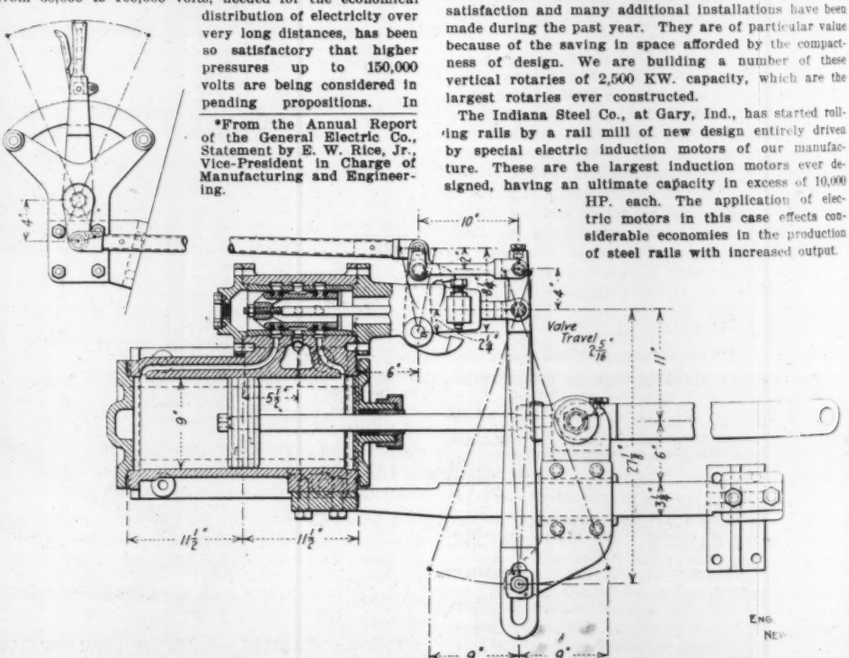



FIG. 8. PNEUMATIC REVERSE GEAR USED ON SOUTHERN PACIFIC MALLET LOCOMOTIVE.

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Whether wood block or granite paving should be laid on Market St., in Philadelphia, is at present a subject of contention in that city. The merchants along the street are said to favor the wood block paving, while the owners of teams oppose it.

The point we would like to emphasize is that the success of wood paving in London, where it is used far more largely than in any other city of the world, is due to the thorough system of street cleaning and sprinkling with gravel. A wood pavement coated with dirt and a slight amount of moisture or frost is exceedingly slippery. In London there are bins filled with clean gravel placed at frequent intervals on every street, and as soon as a light fall of rain makes a street slippery the street cleaner spreads a very little gravel over the surface. This is at once crushed and distributed by the wheels and hoofs, and enables the horses, which are shod with flat shoes without calks, to get a secure foothold.

In New York, where wood pavement has been laid on many streets in the lower part of the city there is no such provision, and on many days the streets with slight grades are almost impassable for loaded teams. In fact, without a change in the American system of horse shoeing, it is doubtful whether the sprinkling with gravel would be as effective here as it is in London, if the system were introduced.

The underground conduit system of electric railways is in use in Washington, D. C., the overhead trolley wires being prohibited within the city limits. Beyond the city boundaries, however, the trolley is allowed. On a number of the street railway lines in the District a change of cars is compulsory at the city line; but on other roads the same car is used for both the overhead and the conduit systems. In such places there is provided near the point of transfer a pit over which the car runs and in which there is a man stationed, whose duty it is to remove or attach, as the case may be, the plow, which, in the underground system, collects the current from the conductor rails.

This work of the pitman is very dangerous. To remove the plow he most raise the upper part of his body well above the level of the street car, so that his life is always in the hands of the motorman, once the plow below, or the trolley above, is connected. Obviously the motorman is not supposed to start his car until he gets the signal from the pitman, who, in turn, is not supposed to give the signal until he has crouched down out of the way of the moving car. But every little while a motorman starts before he gets the proper signal or a pitman signals before he has made himself safe, and the car maims or kills the man below. In addition there is the ever present danger from the high voltage on the conductor rails.

As a matter of record, in the past dozen years during which the various transfer pits around Washington have been in service, there have been at least six men killed, either by electrocution or else by bodily injuries due to some mistake in the signal to start the car. All of these deaths could have been avoided doubtless by proper precaution on the part of the deceased men, but proper precaution has moments of forgetfulness and against the danger of these moments there should be protective appliances. Some sort of interlocking signal which would prevent the starting of the car until the man in the pit was out of harm's way ought to be feasible, and it ought not to be impossible, though it would probably be difficult, to work out some plan of placing and removing the plows mechanically without the presence of a man in the pit. In the absence of these safety devices the only remedy is a better discipline on the railways, the enforcement of which is beyond the reach of mechanical appliances. This, however, is but a slender reed, for the fear of reprimand or dismissal is of small consequence to the man to whom the fear of death is a lesser matter than his own convenience.

In rebuilding San Francisco after the earthquake and fire, a splendid opportunity was afforded for much-needed improvements in the general plan of the city. In order that this opportunity might be intelligently studied and presented to the public, Mr. D. H. Burnham, of Chicago, was engaged at the expense of public-spirited citizens or organizations to prepare the plan. This he did, we understand, to the satisfaction of all concerned; but unfortunately little if anything has yet been done to put the plan into effect.

A portion of Mr. Burnham's plan, we are pleased to note, has just been given favorable consideration by the Board of Public Works of San Francisco and has been reported to the supervisors with a recommendation for its adoption. We refer to Mr. Burnham's scheme for a civic center at Market St. and Van Ness Ave. This would involve the acquisition of a triangular piece of land, the hypotenuse of which is Market St. A large open space would be provided on and back of Market St., with a library building at the right-hand angle, a courthouse at the left-hand angle, and a city hall at the further angle. The estimated cost of acquiring the land is $4,100,000, and it is estimated that the buildings would cost $4,000,000. The tentative proposition under consideration at latest reports was to have the people decide, at a bond election a few months hence, whether this plan should be carried out, or whether the city hall should be rebuilt on the old site. It is to be hoped that the civic center plan will be adopted, and thus something result from the careful and extensive studies made by Mr. Burnham.

We commented, in our issue of April 22, upon the proposed civic center for Springfield, Mass., and also upon a bill which has passed the Pennsylvania Legislature and which provides for clearing away slums and establishing an open park area between the state capitol at Harrisburg and the main line of the Pennsylvania R. R. Other instances of improvements similar to those proposed at San Francisco, Springfield and Harrisburg are being brought prominently to the front almost every day. We noted in our Engineering Literature Supplement some months ago a report of the Capitol Approaches Improvement Commission appointed in Minnesota. This Commission recommended the clearing away of a number of blocks near the Minnesota capitol building in St. Paul. The buildings on this area are of very undignified character, and an open space is much needed there not only to give the capitol building a better setting but in order to afford better access to it. Only a few weeks ago we also noted a proposition for increasing the already fairly large open space about the Colorado capitol at Denver. This improvement seems to be assured. Other projects of this character are in different stages throughout the country, both as regards state and municipal buildings and grounds. They deserve hearty support.

Much is heard nowadays about the destructive effect of motor vehicles upon macadamized roads; but little information is thus far available as to the relative number of motor vehicles and horse-drawn vehicles and the relative wear of the roads caused by each. Since it is usually the case that both classes of vehicles use the same road, it is, of course, impracticable to determine with exactness the relative destruction wrought by each; but it is quite feasible to ascertain how many vehicles of each class use any given road. Elsewhere in this issue we reprint an interesting paper read not long ago by Prof. Arthur H. Blanchard, of Providence, giving the results of a highway traffic census on seven Rhode Island roads, and also drawing some deductions as to the relation of the two classes of vehicles to wear. We refer our readers to the paper itself for details, but call attention to the notable excess of motor vehicles over horse-drawn vehicles on all but two of the seven roads. Altogether, 1,262 motor vehicles passed over the seven roads in eight hours, compared with 695 horse-drawn vehicles. Not only did the motor vehicles largely exceed the others, but the touring cars, of four to seven seats each, were 848 in number, as compared with the 695 horse-drawn vehicles of all kinds. Nearly all the horse-drawn vehicles were of light weight, and most of them had rubber tires. Prof. Blanchard's statistics and comments will repay study, and it is to be hoped that they will stimulate other students of the great road-construction and maintenance problem of the day to make public investigations of the same sort.

## A Comatose Engineering Society.

Time was when the papers and discussions before the Institution of Civil Engineers were one of the greatest and most important sources of useful data for the engineering profession. That time long since passed away. As we look over the batches of papers issued by the Institution at regular intervals, we find very few which present matter of real vital importance to the working engineer. A large proportion of the papers are descriptions of engineering works which have been carried out and descriptions, moreover, which too frequently omit the very things which an engineer needs to know if the paper is to be of any practical usefulness to him.

Such papers, to put it frankly, are mere advertisements for the engineer who did the work, and they are emphatically not the sort of matter which an engineering society should spend its time to hear or its money to publish. In these days of astounding progress in every branch of engineering there is enough of novelty about which engineers need to know without taking time for listening to platitudes or threshing over old straw.

There is also a tendency in the proceedings toward the glorification of such "professorial researches" as have been lately reviewed in these columns—a tendency to confuse theoretical science and laboratory work with practical engineering.

There is evidence that the younger generation of British engineers is fully awake to the "senile paralysis" which has overtaken the Institution and efforts are being made to secure reform.

"The Engineer" of London in its issue of March 26 printed a letter of pungent criticism of British

engineering societies, which seems to us excellent enough to deserve space in these columns, particularly as many leading engineers in the United States hold membership in the Institution. The letter may also serve as a useful guide-post to American engineering societies as to paths which should *not* be followed:

### An Open Letter to the Council of the Institution of ——— Engineers, Westminster.

Gentlemen: You have sent me a copy of Mr. ——'s paper and asked me to take part in the discussion. My reply is, "There is nothing to discuss." You tell me that the paper is a quarter of an inch thick, would take the secretary over two hours to read, has a dozen plates, numerous diagrams in the text, and is illustrated by many samples and specimens. Your statements may be perfectly correct, but the fact remains that there is nothing in it to discuss.

Your author, I take it, has either no opinions of his own or he is so timid for his reputation that he dare not put them to the touch. He quotes well from other people, he describes at considerable length numerous interesting machines, and he records experiments of his own, or tests made for him by unchallengeable authorities. But he never, from one cover of his book—paper is misnomer for such a magnificent production—to the other cover, advances a single statement that will cause flutterings in the hearts of his audience and bring even one of them impulsively to his feet when the signal is given.

You tell me that you have already a long list of people anxious to discuss the paper. I do not doubt it. I could tell you some of them with certainty, and with equal certainty what they will say. One, of course, will slash the title to ribbons; another will take no notice of either paper, title, or author, but describe something of his own; and a third, with laborious care, will pick out sentences here and there and use them for texts of tedious discourses relevant in but little to the subject.

Gentlemen, if that is the kind of "discussion" that satisfies you, you may have much of it. But it is not my idea of a discussion at all, and I, for one, shall take no part in it; I shall in due course bind a copy of Mr. ——'s paper and put it, where I put many of my text books, on the catalog shelf, and so make room for some of the catalogs themselves to take "a higher place." Their honest partisanship merits that honor.

Sirs, I have sat at your meetings for many years; I have seen you grow from a humble society struggling for a bare existence to your present "prosperity," and I say without hesitation that your past weakness was mightier than your present strength. We were but few in the early days, but we had a single object at heart—the honor and progress of our profession. Every one of us told all he knew and all he thought, and our discussions were not a succession of platitudes, but real, living debates, fights almost, at times, such as would quite shock the serenity of the grave and respectable people who incontinently stifle and subdue any element of excitement at your meetings today, and rigidly exclude anything that might be regarded as contentious.

Great heavens! gentlemen, you have made your proceedings as regular and monotonous as the striking of a clock. Nothing is allowed to mar the serenity of their movements, and if one should come amongst you and display some shred of human feeling you would nod your shocked heads together, and pull him up short before the statutory five minutes.

You rejoice annually in the augmentation of your numbers, and once a year you display—Is it you or another society?—a diagram which exhibits your increase of membership. I detest that diagram; it is the banner of your weakness. You are putting on fat, not muscle; quantity, not quality. You wished to grow big, and you have grown big. You "have your desire, but barrenness has entered your soul."

You are a body corporate of civil and mechanical engineers, and civility has become such a part of your natures that you would not strain your manners by contradicting any man, however mischievous his views, whilst mechanics have become so much a part of you that you are a body of automatons. Sirs, you might well call yourselves the Mechanical Institution of Very Civil Engineers! Such flippancy will shock you, I fear, but I am going to say something that will shock you more. You want at your meetings "pipes and porter." Not concrete pipes and porter, of course—Heaven forbid—but the spirit that imbues discussion at a long table when the room is full of smoke and the noise of glasses, and men say what they know and feel without reservation.

Why, Sirs, at one of your meetings recently I actually heard an eminent past-president commend an illustrious member for keeping back some of his knowledge! What an insult to the society! There were we, amongst the best men of our profession, assembled ostensibly to lend a helping hand to each other, and from the very council table itself came praise of the man who gave us a stone when we asked for bread.

After another of your meetings I asked a recognized authority on the subject raised why he had not denied an erroneous statement made by a prominent speaker. He did think of doing so, he said, but it was not worth the while; it was not his business to teach them. If that is the sort of sentiment that is growing up amongst you, your Institution will be as dead and as respectable as Rameses before the century is out. If you wish to continue a useful living body, not a mere mausoleum of great reputations, you must find some of the old spirit again.

Do part with a little of your respectability—I often wonder why we don't all stand up when the Council files in—and encourage a little more human feeling in your discussions. Applaud good points in a speech when they arise, provoke contention, stimulate opposition, divide your house into parties and put them at friendly war with one another; do everything you can to drive a wedge into the grey complacency which has made your meetings a duller form of entertainment than a musical evening.

And for your papers, gentlemen. Let me implore you to have them written with a view to discussion. Have them short and pithy, and put descriptions, if description you must have, in appendices. But let the text deal with broad facts and principles that the mind can grasp, and on which it can form rapid conclusions. Encourage your authors to risk something or find authors who are prepared to do so.

Debatable subjects are to be found. "Plenty of subjects going about," said Uncle Pumblechook in a very similar connection, "for them that know how to put salt upon their tails. That's what's wanted. A man needn't go far to find his subject if he's ready with his salt-box."

Get a fighting Irishman or two into your midst. Someone who will trail his coat and dare you to tread on it; and when you have got him nourish and encourage him. Wave red rags before the bulls of your company. The greatest political truths and the greatest political events have been hammered out, forged, and wrought to perfection by debate, strong, nervous debate, carried on with decency that convention preserves if you will, but, still, as unlike your debates as a hawk is unlike a hack-saw.

Gentlemen, I return you Mr. ——'s paper with the suggestion that you should get someone to write you something that could be discussed; and, with apologies for this letter, which is inspired by the sincerest regard for your ancient Institution, I ask permission to remain

A Silent Member.

The publication of this letter has been followed by some spicy correspondence in our contemporary, and we have selected one of these letters for reproduction here:

Sir: The following particulars of a paper and discussions, which I heard in the latter part of last year, will, perhaps, interest some of your readers taking part in the correspondence now going on in your columns. I went to the meeting at the invitation of a friend.

You will remember, no doubt, the establishment about nine years ago of the Institution of Universal Engineers, intended mainly to consist of men in the drawing-office, managers and foremen. The idea was that their desire for a higher measure of education might be stimulated. There are, I understand, now about 600 members and associates.

The title of the paper was "An Inquiry into the Asymptotic Influence of the Kinetic Integrated Development of Erasmic Polar Curves Raised to the $n^{th}$ on the Efficiency of the Blades of High-Pressure Turbines," by Professor Ebenezer Emilius Saxifrage, D.Sc., of Julius College, Lomanshire. There was a very good attendance, and there were eight members of Council present.

The president, after some usual routine business, expressed his regret that Professor Saxifrage was unable to be present, but the secretary would now read the paper. It consisted of 52 pages of close print bristling with formulas, and seven sheets of diagrams. The secretary spent about an hour in picking out bits of text which he read and then sat down.

The president said that he felt that the Society was to be heartily congratulated on receiving such an extremely valuable paper from a man in so distinguished a position as Professor Saxifrage's, and he called upon the audience to accord the author, with acclamation, a special vote of thanks. This was given with tumultuous applause. The president then said that the meeting was open for discussion.

I did not notice that there was any alacrity manifested by members in availing themselves of the president's invitation. After a pause, however, a member stood up in the body of the hall, and was about to speak when the president interfered and requested him to come to the platform. The member said it was unnecessary, as he only wanted to ask a question. After some wrangling, however, he went to the platform, and then said that he only wished to ask someone to tell him whether the discussion was likely to be over before the last train went. No one seemed to know, so he got off the platform, took his hat, and went away.

Another speaker then rose and said that he felt certain that a more valuable paper could not possibly be written, and for his own part he thank[ed Saxi]frage for it from the bottom of his h[eart] where all was so good it might seem [ill] it seemed to him that the printer had [put] on pages 7 and 8. At all events, the[re was] sion there, and he found one bracke[t] the top and another on page 8 near [the] suming that the printer had not made [it] tured to say with some diffidence [the] quantity which occupied two pages [was] considered unwieldy. This was, howeve[r] of opinion. He would not occupy any [time] of the meeting, but before sitting down [he] express his gratitude to the writer.

The next speaker, a highly enthusiast[ic] large dimensions, wearing huge gold sp[ec]tacles, was in a position to say that if the me[eting] ize the zeal with which Professor Saxif[rage] himself into the turbine question they w[ere] more than ever cordial in the expression [of] tude. He was proud to say that he had [had] view two or three days before with the [Pro]fessor. He would scarcely be believed, but it was [a] fact that the Professor had assured him [that] paper was written he—the Professor—had [no] ever of what was inside a turbine casing. [He] to think that the blades were used to cut [the] into chunks. Busy man as the Professor [was], he contrived to spend nearly ten minutes in [the] speaker's works examining the inside of a turbine [and] questions, the answers to which he did [not] appear at the moment to understand, but he took [them] down in his notebook and would no doubt use them further on. No doubt the ignorance of the Professor might not appear at first sight to add to the value of the paper; but it had already been pointed out by one very eminent mathematician that the man who attacked a problem with an open ignorant mind was much more likely to reach a satisfactory solution than a man saturated with that prejudice which invariably resulted from an intimate acquaintance with actual facts.

When he sat down, a young man—evidently a student—rose. He said he wanted to ask a question, and, to save time, he proceeded to walk to the platform. He took his hat and umbrella with him and a bundle of papers. At last he reached the platform, and began, "Mr. President and gentlemen." He then referred to voluminous notes, which he held in his left hand. After turning them over for an interminable time and dropping his glasses, he said that he was afraid he had left the note he wanted on his seat, and was going back for it when his neighbor picked it up, and it was passed from hand to hand to him. He only glanced at it, and without further preface he said: "The question I have to ask is simply what is this paper about? I have not the least idea. I see a very full meeting of the council, however, and as they have read the paper and accepted it, they can, no doubt, either collectively or individually, tell me what the $n^{th}$ of an Erasmic polar curve is, and what use can be made of it in designing turbine blades?"

A faint attempt at applause was promptly checked. The president then said that as no one else wished to speak, he would close the discussion. He had to apologize in some measure for the paper which was to be read at their next meeting, but it had been set up for some time, and the printer wanted the type. It was by no means of the value or importance of the paper which they had just had the good fortune to hear, being indeed only a short account of experiments made on a new kind of belting, which is a compound of fine steel wire and paper. It could not pretend to possess more than a practical interest. The members would find, as usual, tea, coffee, and cigarettes in the tea room.

I have had, of course, to condense my report, but I have accurately enough given the sense of what took place during a meeting which lasted from 8 o'clock to 10 p. m. Every one seemed quite satisfied.

April 12th. W. Standish.

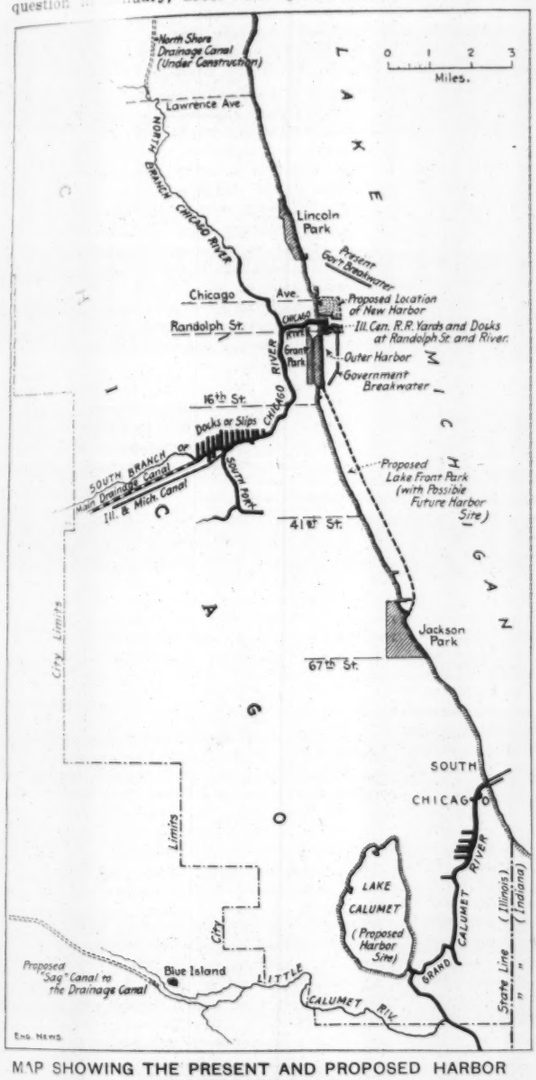
## The Engineering, Commercial and Administrative Problems of Harbor Development at Chicago.

The city of Chicago doubtless owes its location to the harbor facilities offered by the Chicago River near the head of Lake Michigan. The early prosperity of the city was largely due to the fact that the produce of the Mississippi valley was concentrated here to be shipped by water to eastern markets. The city has always had and still has a large amount of water-borne traffic; yet this traffic has remained stationary for a decade past while the traffic of other lake ports has enormously increased.

Of the harbor and shipping facilities at Chicago, it is not much exaggeration to say that like Topsy they "just growed." They have been created by railways, steamship lines, warehouses and manufacturers; and the city itself has done

very little [illegible]er in the way of construction itself, or in [illegible]ding and coordinating the work of private co[illegible]rations.

The action [illegible] one of the park commissions of Chicago in [illegible]uiring the riparian rights of land-owners led [illegible] Mayor to take up the harbor question in [illegible]nuary, 1908. The park commission was planning the establishment of a continuous park along the lake front south from Grant Park (just below the river) to Jackson Park. The Mayor pointed out that the city must decide whether for the future it will depend entirely upon the Chicago River for its harbor facilities or whether it will make provision for utilizing some portion of its lake front. He appointed a special commission to investigate and report upon the improvement of the harbor and shipping facilities of Chicago, and also upon the relations of the harbor to the plans for city, park and railway terminal improvements.




MAP SHOWING THE PRESENT AND PROPOSED HARBOR FACILITIES OF CHICAGO.

The commission represented the business men, the council, the railways, and engineers. The engineers included Mr. John M. Ewen (chairman), Mr. Isham Randolph and Mr. F. A. Delano (all members of the American Society of Civil Engineers). Prof. C. E. Merriam was made Secretary. The commission made its report last month. In view of the municipal problems involved, the high character of the commission, and the very broad and thorough handling of the subject in the report, we have dealt with the matter somewhat extensively in this article.

A brief consideration of the lake traffic and the city's shipping business is necessary to an understanding of the situation. The freight tonnage handled on the great lakes increased from 37,394,000 tons in 1900 to 81,124,000 tons in 1907; this tonnage for 1907 is classified as follows: iron ore, 58%; coal, 24% (19% soft and 5% hard); grain and grain products, 7%; lumber, 3%; miscellaneous (merchandise, fruit, vegetables, etc.), 8%. The traffic of the port of Chicago for 1907 was as follows: receipts, 8,564,754 tons; shipments, 2,845,716 tons; total, 11,410,470 tons. Of the receipts, iron ore represented 62.35%; coal, 16.51%; unclassified, 12.34%. Of the shipments: grain and grain products represented 72%, and unclassified 23.27%.

It is significant that while the traffic of other lake ports has increased enormously within the decade 1897-1907, Chicago has little more than held its own. The total tonnage of cargoes shipped and received in 1897 was 10,643,877; the total for 1907 was 11,410,470 tons. The maximum was reached in 1899, with a total of 12,319,238 tons; the minimum was in 1904, with 8,174,332 tons. During the same decade, the traffic of Duluth was quadrupled (from 4,776,080 to 19,635,800 tons), due to the iron ore development; that of Cleveland and Milwaukee was doubled; from 6,118,731 to 12,247,627 tons for the former, and from 3,750,346 to 7,696,002 tons for the latter.

The port of Chicago, however, includes both the Chicago River and the Calumet River. The former constitutes the city harbor; the latter serves specially a steel manufacturing district remote from the business part of the city. While the traffic of the port as a whole has continued about the same from year to year, the Chicago River harbor has suffered an actual decrease. This is offset in the returns by the increase in receipts of iron ore at the Calumet River. The decline in the former case has been in lumber, coal, grain and iron ore. The loss in iron ore is not accounted for by the increase at the Calumet, this latter being quite independent of the Chicago River ore traffic. In fact an increase in this particular traffic in the Chicago River is not desirable, as it would mean the establishment of blast furnaces, etc., within the city.

Mr. G. G. Tunell, in a report to the commission, refers to the fact that while South Chicago has long possessed a good harbor (in the Calumet River), the increase in its traffic has not been in grain, lumber and miscellaneous freight, but in iron ore alone. From this he argues that the fact of the Chicago River being too small for modern vessels does not account for the development of the grain business at Duluth and the coal business at Milwaukee. It must be remembered, however, that the Calumet as a harbor (in South Chicago) is in a location not adapted to the development of general trade or to serve the commerce of the city of Chicago. Mr. Tunell remarks, however, that the conditions of traffic development at South Chicago:

> Should have a sobering influence on those sanguine persons who feel that deep water in the Chicago River and on the lake front will bring the fleets of the world into the harbor.

As to the decline in the lumber shipping business at Chicago proper, the commission believes that this is due in part to the diminishing supply of timber available for water transportation, but that the decline would have been less if better harbor and terminal facilities had been provided. The decline in coal is more serious, for the neighboring port of Milwaukee shows an enormous increase. The loss is thought to be due in part to a higher freight rate for Chicago (due to difficulties of navigation which may be reduced by river improvement), and in part to the very inferior and antiquated facilities for unloading coal.

It is pointed out in the report that as communities develop varied industries, the movement of miscellaneous freight tends to increase in much greater proportion than that of raw commodities. This miscellaneous freight, it should be noted, represents a much higher value than the bulk freight or raw materials. Thus the value of the 1,134,850 tons of "unclassified freight" moved (both ways) through the Sault Ste. Marie Canal in 1906 was about $48,000,000 more than the value of the 35,337,000 tons of iron ore moved through the canal in the same year. For these two reasons (the growth and high value of miscellaneous freight), the most important increase in the lake traffic of the Chicago River harbor is likely to be in package freight, vegetables, fruit and miscellaneous commodities. But, at the same time, improved facilities should be provided for the traffic in grain, coal and lumber, so as to retain the normal traffic, and not lose it to other ports which offer better facilities. The passenger traffic is also an important consideration, some 2,000,000 passengers being carried in and out of the Chicago River annually.

In considering now the conditions of the harbor of Chicago, we refer only to the harbor facilities at the city; that is in or near the Chicago River. The Calumet harbor is independent (though included in the port of Chicago) and serves a special purpose and district. Improved facilities there, while important in themselves, have no relation to the requirements or developments of the harbor of the city of Chicago. A sketch map of Chicago (showing the several features relative to the harbor question and those mentioned in this article) is given in the accompanying cut. The scale is too small to show the bridges over the Chicago River, but it may be noted that there are about 25 bridges in the distance (8 miles) from the mouth of the river to the entrance of the drainage canal. In the business district of the city these bridges occur at intervals of from one to two or three blocks.

There are four possible locations for harbor facilities: (1) along the river itself; (2) at the upper end of the river and the head of the drainage canal; (3) on the lake front at the mouth of the river; (4) at some point on the lake front more or less remote from the river. The use of the river itself as a harbor is objectionable. Vessels lying along the banks tend to reduce the waterway and increase the current, thus increasing the difficulties of navigation. It has been suggested that the river should be widened from a (future) normal width of 200 ft. to a width of 350 ft., so as to form a harbor. But in view of the great amount of land which would be required in the business districts of the city, and the high value of this land, such a plan appears to be out of the question. Mr. Tunell, whose report has been mentioned already, favors the use of the river, on the ground that it can be made to serve the needs better and more cheaply than a lake-front harbor. He does not believe that there will be such an increase in shipping traffic as to exceed the capacity of the river, and he considers that breaking bulk at the lake front and distributing freight by river lighters would be costly and inconvenient.

An inland harbor, at the upper end of the river (some eight miles from the lake) would be inconvenient in that all vessels would have to run the gantlet of the river, with its bends and about 25 drawbridges. The delays would be excessive, and the cost of handling large steamers would be great, owing to the necessity of employing tugs to control their movements.

The above arguments must not be taken to mean that the river should not be used at all

in connection with harbor improvements. A development in manufacturing industries at the west of the city and along the drainage canal seems most probable, and the development of the river and canal as a link in a through waterway to the Mississippi River is a possibility. For the latter purpose, however, a canal from the Calumet to the drainage canal (avoiding the city of Chicago) would seem to be suitable. This plan was strongly advocated by Major W. L. Marshall, Corps of Engineers, U. S. A., when in charge of the Engineer Office at Chicago. It met with a very unfavorable reception, however, the general idea apparently being that it would detract from the importance of Chicago as a commercial center to have traffic take the Calumet route. However that may be, the river should be regarded as a channel for navigation, and not as a harbor in itself or as an entrance to an exclusive inland harbor. The idea was expressed as follows by Col. W. H. Bixby, Corps of Engineers, U. S. A., in an address before the Chicago harbor commission:

> The river never can be a decent and respectable harbor for the city of Chicago. It can be a magnificent through line of travel to the harbor of the Sanitary District and to the Mississippi waterway.

The river has been encroached upon at various points by private interests, and great difficulty and expense have been incurred in widening and improving it. In 1901, the Sanitary District adopted the recommendations of its engineer for a width of 200 ft., with a depth of 26 ft. for 100 ft., and decreasing to 16 ft. at the dock lines. The narrowest navigable width is said to be at the Clark St. swing bridge, which has two openings of 67 ft. Several center-pier bridges have been replaced with bascule bridges, but those which remain form serious obstructions to navigation by large vessels. The U. S. Government requires all new bridges over the main stem and south branch of the river to have a minimum clear span of 140 ft., but even this gives abutments projecting beyond the 200-ft. dock line, with consequent obstruction of flow and the setting up of eddies and irregular currents which increase the difficulties of handling large vessels.

The commission recommends the adoption of a plan to build all bridges with a clear span of 200 ft. It also recommends that the bridges should have horizontal bottom chords, as curved or arched chords constitute a serious impediment to the free navigation of tugs and lighters which can pass beneath the bridges. It is to be noted, however, that Mr. Isham Randolph, consulting engineer for the Sanitary District and a member of the commission, considers that when the plans for the improvement of the river are carried out there will be no cause for complaint on account of the current.

It is hardly necessary to remind our readers that since the opening of the drainage canal, the flow of the Chicago River has been reversed. The river now draws its supply from the lake and flows westward to the canal. A certain quantity of water in proportion to the population is required for the dilution of the sewage, and this necessitates a fairly strong current. The force of the current to some extent, but the irregularity of the current (due to obstructions, etc.) to a much greater extent, causes considerable difficulty at present in handling large vessels. The close spacing of the bridges accentuates the difficulty, and collisions of vessels with bridges and piers are quite frequent, in spite of the use of tugs. Any rapid movement of the vessel is, of course, precluded by the frequency of the bridges. In the public hearing before the commission it was stated by the agent of one steamship line that bills for tugboat service for a 350-ft. steamer will average $250 per trip in the Chicago River; on one trip, the cost was $320, with lost time amounting to about two days.

The most logical plan evidently would be to provide a harbor which vessels can enter and leave easily and with as little delay as possible, and which has ample facilities of access and for the transfer of freight. These requirements would be met by a lake-front harbor. As to whether this should be located at the mouth of the river or at some distance from the river, it is evident that the former would be the most satisfactory arrangement, as it would give direct access to the river for such vessels as might need to enter it, and would also provide direct facilities for distributing and collecting freight along the river by means of lighters, using the harbor at the river mouth as a terminal. There are already railway lines on both sides of the river. Some of these lake-front and river mouth harbor projects have been noted in our columns (Engineering News, June 20, 1907, and Nov. 19, 1908). The commission's recommendations are for the improvement of the river for navigation, and the establishment of a harbor north of (and adjacent to) the mouth of the Chicago River. In such a location there are ample opportunities for providing railway and other facilities.

But while the commission recommends the river-mouth location, and while it appreciates the public value of the lake front for park development south of the river, it expresses the opinion that this latter development should not be such as to prevent the possibility of utilizing a part of this area for harbor purposes. It suggests two possibilities for the future: (1) a pier extending into the lake from 16th St., having docks or lateral piers on either side and having railway and street connections; (2) the use of the parkway as a breakwater, with a navigable basin or lagoon between it and the shore line; a width of 1,800 ft. would permit of extending piers diagonally from the shore and of providing the necessary railway connections. At 16th St. and 41st St. there are opportunities of connecting with a number of railways.

For many years the city has had a lake-front harbor, south of the river, and formed by a government breakwater parallel with the shore. This is known as the "outer harbor" and is shown on the accompanying map. It has no dock or pier facilities, however, and is available only for anchorage. In point of fact its principal use is as a harbor for yachts in the summer. The area protected by the diagonal breakwater north of the river is used to some extent for anchorage of steamers.

Proper administration of harbor facilities is essential to the efficient use and the commercial development of a port, but in this respect the city of Chicago has been astonishingly neglectful. In fact it has no real administration of the harbor, but various matters of detail have been in the hands of subordinates of different departments, and there has been ample evidence of inefficiency, neglect of duty, and improper political influence. The commission recommends the establishment of a harbor department, headed by a commissioner appointed by the mayor (subject to confirmation by the city council). As to the present condition, the report states:

> There are a number of officers of various kinds engaged in harbor work. These include a harbor master, a vessel dispatcher, a harbor engineer, a bridge engineer, the harbor police, the dredge inspectors and the bridge tenders. But these officers are not properly correlated, nor are they placed under any responsible supervision. The fundamental difficulty is that there is no official who can be considered responsible for the very important work of harbor supervision and administration. Our present harbor administration is defective in that it lacks the essential requirement of a responsible head.

The improvement of the harbor and the reorganizing of its administration must necessarily involve considerable expense, and here the city is in difficulty owing to its financial condition and limitations. In the opinion of the commission, the expense of work undertaken by the city for developing harbor facilities should be met by the issue of bonds. As these bonds would be revenue-producing, they should not be included in the city's debt limit; they should be exempt also from taxation, but under restrictions such as have been proposed in New York. These include an important provision to the effect that the bonds shall be exempt only after their revenue-producing character has been demonstrated in practice.

The report suggests that in making river improvements which will benefit property, the principle of special assessments should be applied, so that those directly benefited will bear some of the expense. Or the city may be given power to condemn more land than is absolutely necessary for the improvement, s[ell] the excess land (when increased in val[ue] by the improvement) may be sold by the [city] proceeds used in defraying the co[st]. This method has been employ[ed] in Europe. Without some such systems as [these] would pay a high price for land [and] would receive no benefit from the [rise] of adjacent property due to th[e] which the city itself effects.

The report of the commission [contains] a series of recommendations, the n[ine] of which we may summarize as fo[llows]:

1. The establishment of a harb[or] in charge of a commissioner, to [be] for the supervision of harbor aff[airs] protection of the shipping interests.

2. The appointment of an engi[neer] to make surveys and prepare plans, specifica[tions] and estimates of cost of the suggested har[bor] improvements. An advisory board should [be] appointed to cooperate with the engineer.

3. The obtaining of a grant from the Illinois legislature of power to acquire, construct and operate (or lease for operation) piers, docks, elevators, warehouses, tracks and terminal facilities; together with power to condemn land required for harbor or dock improvements.

4. Widen the main river to 250 ft., and provide bridges of 200 ft. clear span (with straight bottom chords) on the main river and the south branch.

5. Straighten the river at certain points and provide electric lighting for navigation at night.

6. Widen the north branch of the river to 200 ft., and improve it by dredging and straightening. Also investigate the feasibility of utilizing for navigation the north-shore drainage canal now being built from the north branch of the river to the lake by the Sanitary District.

7. Reserve that part of the lake front from the mouth of the river north to Chicago Ave. and south to Randolph St. for harbor development. In the reservation north of the river, construct piers for the accommodation of steamer lines for passengers, produce and package freight.

8. The preparation of a plan to permit the construction of a lake front park south of the river on lines that will make possible a future harbor development, should this become necessary. This plan to be prepared jointly by experts in park and harbor work, and to be subject to the approval of the city council and the park commission.

9. Widen the Calumet River to 300 ft., and require all bridges to have two openings of 100 ft. each or a single opening of 200 ft.

10. Reserve frontage on the Calumet River for the construction of public docks; and create an inland harbor on Lake Calumet, either by the city or by contract with riparian owners.

## LETTERS TO THE EDITOR.

### The Definition of Monolithic Concrete Masonry.

Sir: In the report of the annual meeting of the American Railway Engineering and Maintenance of Way Association in your issue of March 25, you stated that the conclusion of the committee on Masonry to the effect that concrete arches should be of monolithic construction was adopted. My understanding is that this conclusion was referred back to the committee for a further report, defining the meaning of the word "monolithic."

Yours truly,

C. P. Howard, L. S. & M. S. Ry.

Cleveland, Ohio, April 15, 1909.

[We find from the official report that Mr. Loweth (C. M. & St. P. Ry.) objected to the conclusion on the ground that it was too sweeping. This led to some discussion as to whether the word monolithic meant the entire structure, or that part which might be built as a day's work. The committee took the latter view. Mr. Howard referred to the construction of concrete arches on the voussoir method (in transverse sections) as compared with their construction in longitudinal ribs or sections. On motion of Mr. Loweth it was voted that the conclusion should not be adopted, and Mr. Cartlidge (C., R. I. & Q. Ry.) suggested that there should be presented a definition of the word "monolithic" which will

leave [illegible] as to its meaning. This matter may [illegible] up by the new committee as part of the [illegible] the present year. The conclusion [illegible] submitted (and relating to [illegible] recommended as follows: [illegible] monolithic construction in arches or [illegible] with wing walls, where practicable.—Ed.]

## Water [illegible]ly Anomalies in New York City.

Sir: [illegible]th relish your editorial of April 8, for no one [illegible]es better than we in the water department [illegible]ughly the functions of water-supply are [illegible] it is not at all unusual to see [in a daily [illegible]rial one day on New York's extravagant [illegible]d on the next day a serious condemnation of the [illegible]horities for "forcing poor taxpayers to install meters."

The [illegible] metering part of the supply and charging only from [illegible]e rates for the rest of it is an outgrowth of the [illegible]t the rich who live in hotels or eat in restaurants [illegible] use large quantities of water for industrial purposes [illegible] should be made to bear more than their share, [illegible] the poor may waste water wantonly and the more he [illegible] waste is the more the well-to-do will have to pay. [illegible] the theory of every man who does not want to pay for what he gets. You never see an article on water meters in the daily press that isn't written with the idea that the installation of a meter is a hardship inflicted to benefit some private end, while every experienced water-works man knows that the ultimate and reasonable solution is the metering of the whole supply. As you have pointed out, the meter is the only detector of waste and the only fair method of apportioning the cost. If the householder got his electric light on a flat basis, how much would the consumption increase? And the ratio of saving in water-supply follows the metering of it. If the meter rate to-day is too high, let it be reduced; but even at to-day's price the consumer gets thirty tons of water delivered on his premises for one dollar. It is only a very careless householder who has to complain of the cost of installing meters by the city. He has the opportunity to install it himself, and if he chooses to let the city plumber do the work he has ten days' notice after the bill has been made out in which to question any of the items. I venture to say that every plumber doing business privately has a larger percentage of complaints than have the owners where the work is done by the city. A compilation by the finance department, not long ago, showed that during my term the cost of installing meters had been reduced nearly 40%.

Unfortunately, we have had some decisions in court which have given an opportunity to agitators to cut down the city's revenue. Under a decision given by a Brooklyn justice the department had to remove a great many meters, which, under a more recent decision of a Manhattan justice, should have remained in. It has been literally true that where the Waldorf had to pay for water by meter measurement, a man could build an apartment house twice as large as the Waldorf and get the benefit of frontage rates, providing he did not have a restaurant in the building. It is absurd, too, that the Board of Aldermen should have the final making of rates and of the designation of meters to be used. These are functions that call for more expert knowledge than is found in ordinary legislative bodies. There is, for example, no provision at present for the rate to be charged for a building more than five stories high.

From time to time someone makes a great outcry about the metering of the water used in public buildings. Where water is so valuable as it is in the Borough of Brooklyn, a meter on a public school recently disclosed a consumption of 150 gals. a day for each child attending the school. The officials in charge of school houses, fire houses, docks, hospitals and charitable institutions give little attention to the water consumption, because it does not come into their bookkeeping.

Some day we shall come to it; some day when the newspapers take a little more trouble to inform themselves and their readers of what is going on. In that day, perhaps, when a water commissioner explains that the Croton system below 34th St. is entirely dependent on gravity, he will not be asked by the representative of a great daily why he didn't pump more water there [illegible]. Some day a reporter who has seen five firemen doing their best to handle one high-pressure fire line, will not write a column about the stupidity of the water department in not using the high-pressure system to flush the streets.

Respectfully,

John H. O'Brien,
Commissioner Water Supply, Gas and Electricity.
11 Park Row, New York City, April 19, 1909.

## The New City Charter for Berkeley, Cal., and How It Promises to Work.

The editorial on city charters in your issue of [illegible] is interesting to engineers, all of whom should [illegible] lively interest in municipal government.

The substantial and remarkable growth of Berkeley prompted the framing of a new charter. The present charter was in the main framed some months ago, after weeks of careful deliberation, but because of some advisable change, brought up after a first election had been advertised (for the adoption of the charter) the freeholders were again elected on Nov. 21. This accounts for the short time intervening between the freeholders' election and the presentation of their work, a point to which attention was called in your editorial.

While the population of Berkeley in 1900 is given as 13,214 it is now conservatively estimated at 40,000. There are 8,500 registered voters which indicates, at the usual allowance of five people to each voter, over 40,000; there are 8,035 water connections or services; 4,867 children attend the grammar schools.

Very truly yours,

C. F. Wieland, M. Am. Soc. C. E.
911 Mutual Savings Bank Building, San Francisco, Cal.

[We have received from Berkeley a number of other comments on our recent charter discussion, all save one from members of the Commission that framed the charter. Several of the letters refer to the recent rapid growth of Berkeley in population.

Prof. William Carey Jones, of the Department of Jurisprudence in the University of California, referring to our comments on the brief time taken by the Freeholders (Charter Commission) to frame the charter and our presumption of preliminary work, states that the Freeholders were originally elected in April, 1908, and exhausted their full legal limit of 90 days before reporting. The election called on this first draft was suspended on account of a technicality, and subsequently the same Freeholders were reelected. Between the two periods of election, and also subsequent to the last election, further study was given to the charter, so altogether it is evident that no one could urge lack of deliberation. Moreover, Prof. Jones informs us that in November, 1907, he drafted a "model charter" for Berkeley, which was used as a basis of discussion for the first draft mentioned above.

Prof. Jones refers to the rapid growth of Berkeley in population, for the sake of calling attention to the fact that the "charter was not formed for a village, but for a community that looked confidently forward to a population of 100,000." This point is worthy of consideration by any who may think that the charter was designed and would be suitable only for a place of 12,000 to 15,000.

Mr. Wells Drury, Secretary of the Berkeley Chamber of Commerce, writes us that the charter was unanimously approved by the California Legislature and is now in force. The first election under it will be held on May 1.

Mr. Drury states that there are 5 nominees for mayor, 5 for auditor, about 30 for the four commissionerships or councilmen other than the mayor, and also about 30 candidates for the five school-directorships. He adds:

> The number of good men brought into the race is something unusual, and the result ought to be for the benefit of the community. Party bosses appear to have lost their grip, as new blood is in evidence, the party hacks being relegated to the scrap heap.

President Benjamin Ide Wheeler, of the University of California, calls attention to a feature of the charter which is well worth considering by all who wish to find some means by which the appearance of a large percentage of the voters at the polls will be assured:

> Our method of election, whereby a candidate who in the primary receives a majority may be thereby declared elected, is, I think, fraught with very much possibility of value. It is a new device, so far as I know an utterly new one. It certainly will have one effect—that of inclining all citizens to attend the primary election inasmuch as they can never know that that will not be the final.

The various citations we have made from letters received show how deep and intelligent an interest the citizens of Berkeley are taking in the new charter. As a further instance of this, and also as a further example of the studies of municipal administration made by members of the Commission, we quote the following from a letter written us by Mr. S. N. Wyckoff, of the Berkeley National Bank, who also had a hand in framing the charter:

> I have done some thinking on municipal problems and I believe that the only solution of the many things that at times seem hopeless in this field is in municipal autonomy. I have no faith in state legislatures giving cities good government. I have often thought that if your great city [New York] could be made into a combined city and state government and thus given full control of all its affairs, it would be a great gain, and I believe, too, that it would be as great a gain in good government to the state as to the city.

We look upon these various comments as a most hopeful sign of the present-day awakening to the need of putting municipal government on a better basis, and of the interest in the subject that is engendered whenever thoughtful men turn their attention to it. So long as most well-meaning persons considered municipal government so completely in the hands of political bosses as to be quite outside the range of their influence, it was to be expected that the bosses rather than the people would control city affairs. The facts are that the people really might control their city government under almost any sort of charter, if they would only give their earnest attention to the subject; but they are far more likely to give such attention if the frame of government is such as to facilitate rather than hinder a ready understanding of its underlying principles and working machinery, and, most important of all, if some means are provided for making those who hold municipal offices accountable to the people rather than to the bosses. Nomination by petition or direct primaries, combined with the recall, initiative and referendum, as provided for in the Berkeley and a number of other recent charters, are all conceived with the idea of filling municipal offices by the will of the people rather than in accordance with the schemes of party bosses allied with corporate and other private interests that are seeking special privileges. Limiting the number of elective offices to be filled, as has been done at Berkeley and elsewhere of late and as is proposed in the case of both New York and Boston (particularly Boston), also tends strongly toward making officeholders truly representative of the people, and making them readily accountable to the public.—Ed.]

## The Necessity for Drainage Under Concrete Sidewalks.

Sir: I note in your issue of April 15, p. 417, in a letter from Mr. Robert Fletcher, commenting on the article by Mr. L. J. Riegler, April 1, p. 342, on "Sidewalks," that Mr. Fletcher does not think enough emphasis was placed upon the necessity for underdrainage. My thought on reading the same article was that too much importance was attached to this underdrainage.

The one great fault with nearly all pavements laid is that they are made of dry concrete, and the next great fault is that the finish coat is not applied immediately. It takes but a casual inspection of paving work in any large city to see that both these faults are extremely common. Just a few days ago I noticed some concrete pavement in front of the latest large structure in this city being put down with concrete that showed dry spots as soon as it was tamped. A slab of dry stones with a little mealy mortar rammed in between them cannot help being dished when it hardens. The apparent "upheaval" of the soil beneath is no doubt often the mere shrinking of the top coat, the only real concrete in the pavement. Some pavement in our neighborhood showed these dish-shaped blocks that are supposed to be due to heaving of the soil around the edge of the slab from frost. One of these slabs finally broke in, and a great cavity was exposed beneath it. The pavement had really sunk; there was no sign whatever of lack of drainage nor of upheaval of the ground. If it had been placed on the natural ground, not picked up and loosened and then perfunctorily tamped, after some loose stones or ashes had been dumped in, it would not have caved in so badly, provided, of course, good wet concrete had been used.

I put down some pavement in my yard last fall and I laid it right down on the undisturbed ground. Some blocks are seven or eight feet long. There is no sign of upheaval of the soil. The pavement was made in alternate blocks and was reinforced with old chicken wire and a few ⅛-in. wires.

I see much pavement being laid in the following manner: The paver will put down the base of dry concrete and tamp it. The next day (or if Saturday, the next week) he will put on the top coat. It is impossible to make a first-class pavement in this way. This method is not confined to rural or out-of-town work. It is common in down-town work, in front of large office buildings and in front even of reinforced-concrete buildings, where the contractor is supposed to know how to make good concrete.

There may be cases where underdrainage is necessary, but there are, no doubt, many more where the loosening

up of the ground and imperfect tamping are far more harmful than it would be to leave the ground in a beaten state and lay the concrete on it. Where a pavement occupies the full width between curb and building, as in down-town streets, underdrainage is useless, because the water will practically all wash into the gutters.

Men who have grown gray making concrete pavements are the very ones who insist upon making them of mealy concrete with the finish coat put on sometimes several days after the base is laid. It is clear to see why they use this method. They can lay 100 ft. or more of mealy concrete base and cut slits in it in a sort of way, using a small gang, and then mix their mortar finish some time later with the same small gang and score the surface in the neighborhood of the slits. Troweled smoothly this pavement looks very well from the time it is finished until it is paid for, which is the important time for it to look well. These same practical pavement makers pay great attention to underdrainage. If they would use a few wires in the slabs and wet concrete and make the pavement in alternate blocks, the blocks could be much larger and would be more uniform, less subject to cracks, and better in every way.

Dry concrete, delay in placing the top coat, and excessive troweling characterize the greater part of sidewalk laying. All three are very serious faults and all three are adhered to very tenaciously by the majority of sidewalk layers.

Yours truly,
Edward Godfrey.

Monongahela Bank Bldg., Pittsburg, Pa., April 17, 1909.

[At the last two annual conventions of the National Association of Cement Users the discussion in the section on concrete sidewalks has favored the laying of the walk directly upon the earth footing with no intermediate drainage layer. The question is so largely dependent upon the nature of the earth under the walk that no general rule can be made, but there is no doubt that with a solid clay foundation the three to twelve inches of porous drainage layer is an unnecessary expense, which, in freezing weather especially, may lead to trouble. The suggestion of our two correspondents, that reinforcing be used to resist any heaving tendency, deserves attention, for it will cure, to a large extent, the evils noted by both those who advocate and those who oppose a porous drainage layer.—Ed.]

## More Concerning the Compensation of Engineers.

Sir: I beg leave to offer a brief reply to Mr. J. H. Eby's letter in your issue of April 15. There is no need to congratulate Mr. Eby on his promotion from rear flagman to the top rungs of the engineering ladder. Mr. Eby seems to be singularly able and talented, as well as fortunate, man and would probably have made his mark in any field, even in literature and fiction, judging by the charming style of his essay.

Most of the workers in engineering, however, are of average intelligence and ability. Moreover, on graduation they do not start out burdened with a carload of steamer trunks and with letters from the president of the concern who happens to be their father's friend. They are burdened by debts and sometimes by families, and must at once earn enough to subsist on. They cannot and will not work hard and long hours for a pittance if they have a spark of manhood in them.

After a period of six to ten years when the cubs, fully grown, have reached the end of the tether and find that somehow they cannot get beyond the magic boundary of $100-$125 per month, they begin to think that there is something wrong in the optimistic philosophy of Mr. Eby. They conclude that the engineering profession is not composed of generals and lieutenants, but is a regular army of privates and officers of all ranks; that the private and petty officer have little or no chance to become generals.

They see that their limit is very much like that of the mechanic; that, in fact, they are but intellectual workingmen. From that conclusion to organization is but an easy step.

It is for this reason, as well as for the purpose of "closing" the profession and kindred aims, that the Technical League was founded.

If Mr. Eby took the trouble to scan the want columns of Engineering News in which his article appeared, or any other similar magazine, he would easily notice three things: First, the immensely greater number of men seeking positions than of places seeking men; second, the number of men of large experience, both in kind and in length of time, willing to work for low salaries; third, correlated with the second, the high requirements the employers place for responsible jobs at $90 to $100 a month. This seems to point to an army of privates, not of generals.

I have received hundreds of letters from all parts of the United States, Canada, Mexico, Cuba, Porto Rico, Philippine Islands and Panama with eager inquiries about the League, congratulations and best wishes. These letters are from instrumentmen, draftsmen, assistant engineers, chiefs, consulting engineers, college professors, municipal engineers; from architects, electrical, mechanical and mining engineers; from humble subalterns and from members of the American societies; from men of national and international reputations; some wishing to join, others writing to encourage and speed us in the work, others asking for information to disseminate among their associates and subordinates when themselves out and above the line of discontent.

If Mr. Eby saw the names and read the letters I have received, he would agree that the profession have at last awakened and that our organization is filling a long-felt want.

Finally, as the best objective proof of my contention, is the truly startling growth of the Technical League since its inception, when it becomes necessary to establish chapters at different localities, and the officers are breaking down under the heavy stress of work imposed on them.

The League has come to stay and will grow and become a powerful factor in the profession and in the building-up of this country.

Would it not be more generous of editors and of men like Mr. Eby to give us substantial support, instead of illusory encouragement, particularly as the advancement to the privates would necessarily also raise the value of the generals who would get compensation approaching that of high-grade lawyers?

To-day, the generalissimo in engineering is rated only at 24 hod-carrier power, in the picturesque phrase of Mr. Gillette.

Respectfully yours,
The Secretary of the Technical League,
721 Park Row Bldg.,
New York City.

Sir: I have read from time to time the comments of the members of the profession regarding the remuneration received for services rendered.

Our whole profession heretofore (and I see no reason why not always in the future) have always been "bush shakers" instead of "bird catchers." Let a railway company collapse, and who lose the money due them? Invariably the engineers. The courts have decided that engineers are not "laborers" so we cannot make a lien stick—even when there is anything to lien.

The medical profession, in about every State, have protected themselves against quacks, but I know of only one State (Louisiana) in which there is any law relating to engineers or surveyors.

In Canada no one's evidence is admissible relating to land surveys except Provincial or Dominion Land Surveyors. On this side of the border we never have had gumption enough to get any protection from laws. We made a few feeble attempts in Minnesota to get some protective legislation, but without results.

Engineering is the poorest paid profession without any question. Who ever heard of an engineer making more than a living out of his professional work? When it becomes necessary on a railway to cut down expenses, the engineers suffer first. They can always get along without us.

We fight mosquitos, wade swamps, work from sun to sun, scheme and try to get the best at the least cost with the usual result—that from the hind end of an observation car the directors on an inspection trip see a good deal better place to have built the road.

Locomotive engineers of the first class will draw about $200 per month the year round. Passenger conductors, $150; freight brakemen on the large systems, especially in the mountains, get as much as the Division Engineers.

With a college education and 20 years' experience, how many engineers are receiving $4,000 to $5,000 per annum? Are there any?

I don't believe there is any large railroad system which pays the head of its legal department less than $10,000, with a half dozen assistants at $5,000.

An architect may get one State Capitol building and is rich for life. A surgeon may perform one operation that will make him independent. A lawyer may win one important case and he does not have to work any more. Who ever heard of an engineer having such luck? There is more money in the "laundry business."

The average engineer is a rank failure as a contractor. The only good (from a financial standpoint) the profession is, is as a stepping stone to the operating end where there is a chance to show money results.

I never heard of but one case where an engineer was paid more than his salary. That was A. B. Rogers, who located the Canadian Pacific Ry. over the Selkirks. Mr. Van Horne gave him a present of $5,000 in appreciation of what he had accomplished. The task cost Rogers his life, by the way.

Rogers has never had a peer as a locating engineer. His estimated distance (by his legs) down the Kicking Horse Valley (about 15 miles) was within half a mile of the actual; and his height of the summit with aneroids was within 15 ft.

Here is where I can laugh: The Canad[illegible] sent one expedition out there which [illegible] months, spent $50,000, ran about two mil[illegible] back and couldn't tell where it had been.

E. T. Abbott, M. A[illegible]
Pokegama, Oregon, April 5th, 1909.

## Sympathy for the Young Engine[illegible] Troubles.

Sir: Upon reading the letter by Mr. [illegible] the April 15 issue of Engineering N[illegible] could not make up his mind whether to over the sad experiences of the "cub Engineering News has seen fit to publ[illegible] tale, the writer would be glad of a little the exploits of another class of engineers.

Some years ago the writer had charge o[illegible] veys in the anthracite coal regions for the R. R., Mr. Samuel Rea, now Vice-Pres[illegible] general charge, and that veteran railroad P. F. Brendlinger, having immediate [illegible] Engineer.

The entire party was composed of m[illegible] young men, and in truth I must record th[illegible] of them wore white collars, and many of [illegible] shirts," in fact their habiliments betokened the gentleman, if that appellation can be applied to a man who wears a derby hat, and several were guilty of being partial to that style of head gear. The party was not obliged to come in just before dark, but through the munificence of the Pennsylvania Railroad were provided with hacks, or in case of snow with sleighs, as means of transportation, making it possible to reach headquarters which was usually the best hotel in town, in time to dress and be ready for dinner, at which it must be recorded with shame some of them appeared adorned in dress suits.

Early in December of a year not necessary to mention word was received that a certain location between Delano and Hazleton, Pa., must be started and finished before Christmas, or there would be no usual holiday vacation. As the distance was 20 miles and over very rugged country, considerable hustling would have to be done.

The party was on the ground early one Tuesday morning rain falling, which turned later on into snow, then growing colder the following days with more snow, but the "dudes" were not easily discouraged by adverse weather conditions, and the work of running the center lines, with stakes every 50 ft. went merrily on, and at the end of that day's work, two miles had been reeled off. This accomplishment of course set the pace for future operations. By Saturday night 10 miles of center line had been run, and when the character of country traversed is considered, "uphill and down dale," with 50% of curvature, excellent progress had been made.

Our western friends of course would not have stopped for the Sabbath, taking advantage of an extra day; but not so with our "Christian engineers," to whom a day of rest was doubly restful. The work was attacked with renewed vigor on Monday and notwithstanding rainy days, snowy days and a little occasional sunshine, when Friday evening arrived the task was accomplished.

Twenty miles of final location had been run in by a "band of dudes," an average of two miles a day, and in country where one mile in summer weather would have been called a good day's work.

The main cause for the excellent progress was that some time previous a very careful preliminary survey had been made, along with very careful topography, contour intervals of 5 ft. taken on the ground, the same carefully plotted on standard sheets, 19 × 24 ins., then the location line projected and all details of the same worked out with mathematical precision which included center angles of curves and lengths of intervening tangents. During the day frequent measurements were made to the preliminary line, stations and places of crossings noted, and exact locations of all P. C.°, P. C. C.° and P. T.° determined.

At the same time that the work just mentioned was being done, the Lehigh Valley R. R. had a party of engineers in the field in the same locality. The "old man" in charge was a druggist, who at this particular time had delegated the work of compounding pills to his clerk and had taken the field to practice the gentle art of locating railroads by the practiced eye.

His corps of assistants consisted of sturdy yeoman recruited from a gravel train. The rendezvous of this gravel train was miles away from the scene of operations, necessitating a long mileage long before the early dawn as well as during the long watches of the night, for darkness comes early in the winter season.

It certainly was an inspiring sight to see men whose usual occupation was the wielding of picks and shovels engage in the practice of surveying, and do stunts that even Prof. De Biggers did not know about.

The one redeeming feature was that they did not even receive the usual gravel train pay of $1.25 per day, but were content to labor at a novel occupation for the princely stipend of $1.00 per day and board themselves.

the writer desires to emphasize is that should be done by men having scien- and that the laborer is worthy of his

for men to preach about working for their professional pride ought to deter so. Of course if circumstances compel that is another matter.

knows of a certain narrow-gage railroad er received $35 per month and the prin- engineer (also acting as chief engineer) but he would not like to see this "scale rally applied. Yours truly,

Emile Low, M. Am. Soc. C. E.
Ave., Buffalo, N. Y., April 19, 1909.

## The Duty of Engineers to the Profession.

Sir: In commenting on my letter published in your issue of April 15th, you say: "We fear our correspondent overestimates our ability to solve knotty problems." With all due respect to the modesty of the Editor, I venture to say that the ability of "Engineering News" to assist in solving the knotty problem under discussion has not been overestimated by me. I estimate that ability very highly and the proof is this:

You say: "If the engineer of high or low degree were to realize that it is his duty to the profession and his duty as a citizen to use all his influence in support of sound engineering and competent engineers and his duty also to condemn all cases of incompetency and lax professional standards in engineering work—if engineers themselves would do this—they could effect a great deal for the benefit of their profession and the public."

Now it is along just this line that the influence of Engineering News can be of great help. Engineers of high and low degree are now inclined to say: "What's the use," when it comes to publicly condemning incompetence and lax professional standards on the part of "quack" engineers, and, however much they may deprecate these things, they keep silent, largely, I believe, through dread of having their motives impugned.

If, as you say, engineers can be brought to realize and to perform the full duty which they owe to the public and to the profession, the public and the profession will be greatly benefited.

I believe that the advocacy of this principle by great engineering publications like Engineering News will do much to encourage the conscientious but timid engineer to expose "fake" engineers and engineering wherever met with. Yours respectfully,

Edwin F. Dwelley.

Lynn, Mass., April 22, 1909.

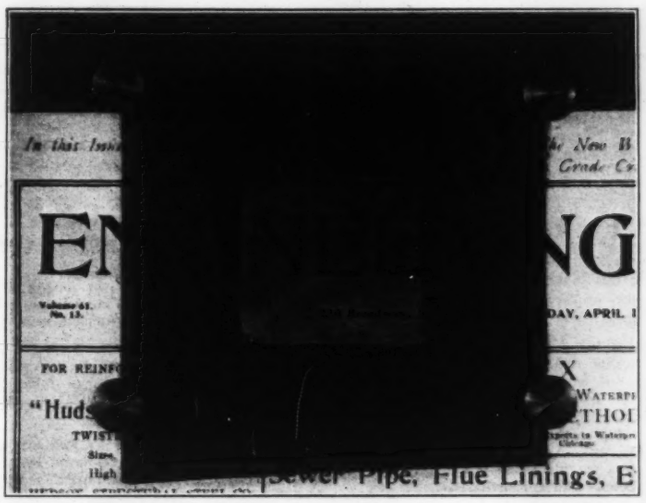
[We will venture to make a concrete application of our correspondent's suggestion. We will apply it to some of the attacks which have been made upon the accepted plan for the construction of the Panama canal. We do not object by any means, be it understood, to fair and honest and intelligent criticism and discussion of this or any other engineering enterprise. What we do object to is attempts to deceive the public by misstatement of facts, by innuendo, by misquotations from records, by attacks upon the professional honor of the engineers who are responsible for the present plans and present work at Panama. Such acts as these, we believe, constitute professional dishonesty. They tend to destroy the confidence of the public in the profession, and hence all reputable and honorable engineers should be united in their condemnation.

And we take the Panama work merely as an illustration. Whatever the work in which he is engaged, the engineer has always one safe guide—the truth. If he tries to deceive Nature or fails to learn her truths, he will come to grief. If in his desire to serve either his own interest or his clients he departs from the truth, he deserves the same fate. We are not thus condemning, of course, honest error—no one is infallible; anyone may make a mistake. What we do condemn is the man who, to win his case, tries to make black appear white. The best asset the engineering profession has is its reputation for honesty. It is the duty of every engineer to preserve that reputation unsullied.—Ed.]

BETTER ENGINEERING in the design and operation of steam power electric stations might have saved $37,000,000 in the United States last year, according to the estimates made by the Stone & Webster Engineering Corporation of Boston. It estimates that the total output of electric energy from coal at 15,000,000,000 horse-power-hours per annum and states that good design and operation might have saved on the average ¼ ct. per horse-power-hour in the cost of generation.

## A Severe Test of a Metal-Protecting Coating.

We illustrate herewith a notable test of a coating for protecting metal from corrosion, which has recently been put on the market by the Glidden Varnish Co., of Cleveland, O. The coating referred to, which is a transparent varnish, was applied to one side of a thin brass plate




BRASS PLATE WITH ITS CENTER EATEN AWAY BY ACID, LEAVING VARNISH FILM COVERING ON OPPOSITE SIDE INTACT.

about 4 ins. square. The other side of the plate and its edges were also covered with the coating, with the exception of an area about 1 in. square at the center, which was left bare. After the coating had dried for 24 hours, the plate was placed in a bath of 30% nitric acid, and in an hour and forty minutes the unprotected part of the plate had been entirely eaten away, leaving the acid-proof varnish film on the other side intact. It will be evident from this test that the coating was entirely unaffected by the acid and that the protective effect on the part of the plate which had both sides covered was complete. The accompanying cut is a photograph of the plate laid on the cover of Engineering News, and shows the transparent film in the center of the plate.

## Notes From Engineering Schools.

UNIVERSITY OF MINNESOTA.—It has been announced that the engineering course is to be extended to include six full years of attendance and that the new plan is expected to go into effect in September, 1910. The course has already been increased to five years and all students who entered last fall are taking a year of preliminary work in the College of Science, Literature and the Arts. Corresponding changes are to be made in the other professional courses, in accordance with the regents' policy of requiring a year or more of academic training for all candidates for professional degrees.

UNIVERSITY OF WASHINGTON.—Great activity is now manifested on the portion of the Campus which is being used for the Alaska-Yukon-Pacific Exposition. The buildings, lawns and roads are so nearly completed that, with exhibits already arriving, there is reason to believe that everything will be ready for the opening day, June 1. The university's laboratory for structural materials will be used during the exposition by the U. S. Forest Service for exhibition tests of timber. The equipment is being supplemented by an impact machine which has been designed by the Forest Service and is being constructed by the university in its own shops. The hammer has a maximum weight of 1,500 lbs., and has automatic and autographic attachments both for continued drops from the same height and from increasing heights. Mr. Chas. Evan Fowler, M. Am. Soc. C. E., recently delivered an address to the engineering students on the "Architectural Features of Engineering Masonry."

NORTHWESTERN UNIVERSITY.—Instruction in the first three years of the new engineering course is now offered in the recently completed Swift Hall. The course will be extended next fall to four years, and students who enter in the fall of 1910 will take a complete five-year course. The new building is of Bedford limestone, five stories high, with ground dimensions of 125 x 54 ft. The mechanical and electrical laboratories are in the basement and on the first floor is the hydraulic laboratory and a lecture room with a seating capacity of 200. The library is on the second floor and the balance of this and the entire third floor is given over to recitation rooms, offices, etc. The two upper floors, for the present, will be used chiefly for storage purposes. Mr. John F. Hayford, M. Am. Soc. C. E., is to be Director of the Engineering School, and has resigned his position with the U. S. Coast & Geodetic Survey, to take effect next fall. The dedication of Swift Hall will take place on May 7. The dedication exercises will include an address by Mr. Charles Whiting Baker, of New York City, Editor of Engineering News.

THE "MAURETANIA" MAINTAINED A SPEED OF 29 knots over the last 200 miles of her trip ending at Liverpool April 20. This is the highest speed ever recorded for an ocean liner. The record run was made over the course from Queenstown to Skerries Islets.

AN EXPLOSION ON THE SUBMARINE BOAT "Foca," of the Italian navy, April 26, in the harbor of Naples, resulted in the death of seven men and the injury of several others. The boat was sunk.

ANOTHER FATAL HOTEL FIRE occurred in Topeka, Kan., on April 24. The Central Hotel, a two-story brick structure in the business district, was destroyed, and four persons, one an employee of the hotel, were killed. The cause is given as "crossed electric light wires."

THE UNITED STATES DREDGE "CLATSOP," which started from Philadelphia, Dec. 9, 1908, for a 17,000-mile trip around Cape Horn to Portland, Ore. (Eng. News, Dec. 17, 1908, p. 674), reached that port April 20, making the voyage under her own steam in 132 days, 54 of which were spent in various ports taking on coal and supplies.

THE RED STAR LINER "LAPLAND," the largest and newest vessel of that line, reached New York on her maiden voyage April 19. The steamer is the largest that could be built to enter the port of Antwerp, her terminus on the other side of Atlantic. She is 620 ft. long and 70 ft. broad, with a gross tonnage of 18,694 tons. She is driven by reciprocating engines connected to twin screws. Especial attention has been paid on the "Lapland" to the first and second class passenger accommodations. Although she is by no means the largest steamer now entering the port of New York, her seating and berthing capacity for first-class passengers is passed only by one or two of the very largest ships. With this increased accommodation for passengers, is also a highly developed style of interior decoration and furnishing.

PROTECTION FROM FLOODS at Augusta, Ga., is to be undertaken by the city. Levees and drainage channels will be built and about half a million dollars will be expended.

HARBOR IMPROVEMENTS TO COST $9,000,000 on the part of San Francisco are authorized by a bill just passed by the California Legislature. The scheme must have the sanction of the voters of the city. The bill authorizing the expenditure was drawn for and pushed by the Merchants' Association of San Francisco.

LOWERING THE GRADE of the portion of Pittsburg known as The Hump, or Grant's Hill, has been under consideration for some time past. The scheme has reached the stage of an estimate of cost, prepared by the Board of Public Works, placed at $1,165,000 for removing the hill, $300,000 for damages to street railways, and $2,000,000 for damages to private property and contingencies, making a total of $3,465,000. From a sketch map published in the Pittsburg "Dispatch" of April 15, it appears that upwards of thirty city blocks are involved, and that the maximum depth of material to be removed is 17.9 ft. Mr. W. A. Magee has recently taken office as Mayor of Pittsburg.

BIDS FOR A SLOW-SAND WATER-FILTRATION plant for Toronto, Ont., are to be received on May 18. Twelve covered filter beds, with an area considerably under an acre each, a covered clear-water reservoir with a capacity of about 9,000,000 U. S. gals., seven sand washers of the ejector type, a pumping station and a laboratory are proposed. Concrete will be used for the filters and reservoir, including the groined arches for both. Reinforced concrete will be used for some hundred feet of 72, 54 and 36-in. pipe, 6, 5 and 4 ins. thick, respectively. Plans and specifications for the work have been prepared by Hazen & Whipple, Consulting Engineers, 103 Park Ave., New York City. Mr. C. H. Rust, M. Am. Soc. C. E., is City Engineer of Toronto.

OVER 1,000,000 SEEDLINGS are being distributed by the State of New York for planting this spring. The seedlings are of pine and spruce and have been supplied at cost to 149 persons, located in 48 counties. The number of seedlings per county ranges from 50 for Monroe County to 104,000 for Essex County and 201,000 for Oswego County. It is interesting to note that property owners in Nassau County, the area of which was originally included in the consolidation which constituted Greater New York, take 67,400 of these seedlings. Besides supplying the seedlings at cost, the state furnishes a foreman to direct the planting, so far as feasible. Property owners pay a proportionate amount of the salary of the foreman, together with his expenses. These operations are being carried out under the direction of Mr. James S. Whipple, Forest, Fish and Game Commissioner of New York State, and Mr. C. R. Pettis, State Forester.

CANADIAN BOUNDARY SURVEYS are to be continued in the coming season. Supt. O. H. Tittmann of the U. S. Coast & Geodetic Survey and Dominion Astronomer W. F. King are arranging for work on part of the northern boundary line of the United States and the Alaska boundary.

A HOT-WATER FOUNTAIN has been established at the health resort of Thermopylis, Wyo., and consists of a 6-in. standpipe 28 ft. high on the pipe line running from the Big Spring to the sanitarium and bathhouses. The water falls into a concrete basin from which it flows to the river. The temperature of the water is about 135° F., and the steam effect is said to be very attractive on cool days. The fountain was built by the Havemeyer Construction Co., of Chicago.

CEMENT PRODUCTION IN THE UNITED STATES during the calendar year 1908, contrary to the preliminary reports that have been issued, shows an increase over any preceding year. The figures for the past two years, as given out in a preliminary report of the U. S. Geological Survey, are as follows:

| | 1908 | | 1907 | |
|---|---|---|---|---|
| Cement. | Bbls. | Value. | Bbls. | Value. |
| Portland .. | 51,002,612 | $43,472,679 | 48,785,390 | $53,992,551 |
| Natural .. | 1,621,862 | 808,509 | 2,887,700 | 1,467,302 |
| Puzzolan .. | 151,451 | 95,468 | 557,252 | 443,998 |
| | 52,775,925 | $44,376,656 | 52,230,342 | $55,903,851 |

In a paper read before the Association of American Portland Cement Manufacturers, Dec. 8, 1908 (Eng. News, Dec. 24, 1908, p. 731), Mr. E. C. Eckel, the government cement statistician, predicted a total production of Portland cement in the United States of about 48,000,000 bbls. This prediction was based on returns from the cement mills of the eastern and southern states. In Pennsylvania, New Jersey, New York and Michigan there were decided reductions in production. This decrease was offset by remarkable gains reported from plants in the middle west and the Pacific coast, particularly in Indiana, Illinois and California.

The increase noted in the Portland cement production in 1908 is about at the same rate as has been recorded for the past few years. The natural and puzzolan production, on the contrary, has so diminished that the total rate of increase of the three kinds of cement fell off in 1908.

The preliminary report further says:

The average price [at the mill—Ed.] of the entire Portland cement output in 1908 was only 85 cts. a bbl—36 cts. below the average price in 1907. The 1908 price is the lowest on record, the previous low point—88 cts. a bbl.—having been reached in 1904 as the result of business depression in that year.

## Personals.

Mr. J. R. Harrigan, of Buffalo, N. Y., has been appointed General Superintendent of the Columbus, Delaware & Marion Ry.

Mr. J. W. Dawsey, Superintendent of the northern division of the Canadian Northern Ry., with headquarters at Dauphin, Man., has resigned.

Mr. F. A. Delano has resigned his position as President of the Wheeling & Lake Erie R. R. and has been succeeded by Mr. Edwin Gould.

Mr. Alexander Potter, Assoc. M. Am. Soc. C. E., has been elected an honorary member of the Association of Managers of Sewage Disposal Works, of Great Britain.

Mr. Jean Bart Belcomb has severed connection with the Lake Construction Co. and has opened an office as a consulting engineer at 184 La Salle St., Chicago, Ill.

Mr. W. D. Robbins, City Engineer of Niagara Falls, N. Y., will retire from that position May 1 to become Engineer for the Board of Water Commissioners of that city.

Mr. F. H. Thomas, formerly Superintendent of the Bellefont Central R. R., has been made Vice-President and General Manager. The office of superintendent has been abolished.

Mr. John C. Grady has resigned his position as Director of the Department of Docks of Philadelphia, Pa. His resignation will take effect upon the appointment of his successor.

Mr. A. M. Shaw, Assoc. M. Am. Soc. C. E., has temporarily closed his office at Dixon, Ill., to take up special work in southern Louisiana for the U. S. Department of Agriculture.

Mr. S. R. Dungan has been appointed City Engineer of Boulder, Colo. He was until recently employed by the Denver Reservoir & Irrigation Co. in connection with work on the Standley Lake project.

Mr. Welton H. Sears has been appointed Division Engineer of the Charles River Basin Commission in charge of the Office at Boston, Mass., to succeed Mr. Edward C. Sherman, Assoc. M. Am. Soc. C. E., resigned.

Mr. Edwin P. Dawley, M. Am. Soc. C. E., Engineer of Construction for the New York, New Haven & Hartford R. R., has established an office as a constructing and consulting engineer in the Banigan Bldg., Providence, R. I.

Mr. R. M. Raymond, M. Am. Inst. M. E., formerly General Manager of the El Oro Mining & Railway Co., has become Managing Director, with headquarters in Mexico City. He will be succeeded as General Manager by Mr. Alfred F. Main, M. Am. Inst. M. E., formerly Assistant General Manager.

Mr. Harry Barker, Assoc. Am. Inst. E. E., Associate Editor of Engineering News, was married on April 21 at Burlington, Vt., to Marion I. Booth, daughter of Col. and Mrs. Edward J. Booth. The ceremony was performed at the Booth residence on College St. Mr. and Mrs. Barker will reside at Montclair, N. J.

Mr. W. H. Kirkbride, formerly Assistant Resident Engineer of the Sacramento division of the Southern Pacific Ry., has been appointed Resident Engineer of the Coast division with headquarters at San Francisco, Cal., to succeed Mr. C. K. Clark, resigned. Mr. Wm. M. Jaekle has been appointed to the position vacated by Mr. Kirkbride.

## Obituary.

Louis Lacoste, inventor of the ship brake soon to be tested on the U. S. S. "Indiana," died April 13 in Montreal, Can.

Benoni Lockwood, formerly President of the board of fire underwriters of New York City, died April 27 at his apartments in New York City. He was born at Providence, R. I., in 1834 and was a graduate of the University of Pennsylvania in the class of 1852.

Mace Moulton, M. Am. Soc. C. E., died from heart disease April 27 as he was entering the Ansonia Hotel in New York City. Mr. Moulton was born at Manchester, N. H., in 1854, and graduated at Dartmouth College and the Thayer School of Engineering. He came to New York City seven years ago, and at the time of his death was President of the Millbrook Co., in New York City and also maintained an office as consulting engineer. He is survived by his wife, two sons and a daughter.

Robert G. Curtis, formerly Superintendent of the Northampton division of the New York, New Haven & Hartford R. R., died April 20 in Northampton, Mass. Mr. Curtis was 75 years old. He became Assistant Superintendent of the Northampton division in 1871 and was made Superintendent 20 years later. When the Northampton and Air Line divisions were combined, he became Assistant Superintendent of the new division thus formed. He resigned in 1904 on account of ill health.

Rear-Admiral William J. Barnette, U. S. N., retired, Superintendent of the Naval Observatory, died April 19 at the Naval Medical School Hospital in Washington, D. C. Rear-Admiral Barnette was b[orn] N. Y., in 1847, and graduated at Anna[polis] became an ensign in the following y[ear] sequently promoted through the vari[ous] ing a commander in 1899. His promo[tion] rear-admiral occurred in 1898 and he [was] the retired list Jan. 31, 1900. He as[sumed] perintendent of the Naval Observatory [in] and remained in that position up to the

Nathan Pratt Towne, Chief Engine[er] Son's Ship & Engine Building Co[.] at his home in Philadelphia. He was Me., in 1844. Mr. Towne enlisted in [the] the beginning of the Civil War and to[ok] every engagement of importance along board. After the war, he became an Naval Academy and later served as an Government. He resigned in 1894 to [be] of the Cramp company, of which he ha[s] gineer for the past four years. Mr. Tow[ne] ber of the Society of Naval Architects a[nd] neers.

John Dennin Hall, formerly Chief Engi[neer] Coburn Co., of Philadelphia, died April [in] City. Mr. Hall was born at Salisbury, [Herkimer Co.,] N. Y., in 1828, and is said to have been [the] alumnus of Union College, where he was [graduated] 1854. After leaving Union College, Mr. Hall took a special course, receiving degrees in both civil and mechanical engineering. While in the employ of the A. Coburn Co. he invented a machine for manufacturing the large thermometers commonly used for advertising purposes and he held patents for a large number of other devices. At the time of his death he was at work on plans for a new aeroplane propeller.

## Engineering Societies.

COMING MEETINGS.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION.
April 27 to 30. Annual meeting at Louisville, Ky. Secy., H. D. Vought, 95 Liberty St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
May 4-7. Spring meeting at Washington, D. C. Secy., Calvin W. Rice, 29 West 39th St., New York City.

AMERICAN ELECTROCHEMICAL SOCIETY.
May 6-8. Annual meeting at Niagara Falls, Canada. Secy., Jos. W. Richards, Lehigh University, South Bethlehem, Pa.

AIR BRAKE ASSOCIATION.
May 11-14. Annual meeting at Richmond, Va. Secy., F. M. Nellis, 53 State St., Boston, Mass.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
May 18-20. Annual meeting at Cincinnati, Ohio. Secy., Richard Moldenke, Watchung, N. J.

AMERICAN RAILWAY ASSOCIATION.
May 19. Annual meeting at New York City. Secy., W. F. Allen, 24 Park Place, New York City.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 25-27. Annual meeting at New York City. Secy., W. H. Merrill, 382 Ohio St., Chicago, Ill.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
June 1-4. Annual convention at Atlantic City, N. J. Secy., W. W. Freeman, 29 West 39th St., New York City.

AMERICAN WATER-WORKS ASSOCIATION.
June 8-12. Annual convention at Milwaukee, Wis. Secy., John M. Diven, 14 George St., Charleston, S. C.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 16-18. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

MASTER CAR BUILDERS' ASSOCIATION.
June 21-23. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 39 Old Colony Bldg., Chicago, Ill.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
June 21-23. Annual meeting at Chicago, Ill. Secy., D. B. Sebastian, C. & E. I. R. R., 327 La Salle Station, Chicago, Ill.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS.
June 23-25. Annual meeting at Detroit, Mich. Secy., P. W. Drew, Wisconsin Central Ry., Chicago, Ill.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
June 24-25. Semi-annual meeting at New York City. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 28. Annual convention at Frontenac, N. Y. Secy., Ralph W. Pope, 33 West 39th St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 29-July 3. Annual meeting at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
July 6-9. Annual convention at Bretton Woods, N. H. Secy., Chas. W. Hunt, 220 West 57th St., New York City.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
July 15-16. Summer meeting at Indianapolis, Ind. Secy., W. M. Mackay, P. O. Box 181[8] New York City.

NEW YORK ELECTRICAL SOCIETY.—At the meeting to be held in New York City April 29, Mr. B. A. Behrend, M. Am. Inst. E. E., will lecture on "The Design and Characteristics of Modern Electric Machinery."